



Charles E. Kellogg

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GOLD COAST DEPARTMENT OF SOIL AND LAND-USE SURVEY

REPORT ON THE WORK ACCOMPLISHED BY THE SOIL
SURVEY ORGANIZATION OF THE GOLD COAST
SINCE THE GOMA SOILS CONFERENCE IN
NOVEMBER, 1948.

By

C.F. Charter
Director
Soil and Land-Use Surveys

(Paper presented to the C.C.T.A. Inter-African
Soils Conference, Leopoldville, 1954).

KUMASI
May, 1954.

REPORT ON THE WORK ACCOMPLISHED BY THE SOIL
SURVEY ORGANIZATION* OF THE GOLD COAST
SINCE THE GOMA SOILS CONFERENCE IN
NOVEMBER, 1948.

As stated by Charter (1) in his paper presented to the Goma Soils Conference, soil surveys in the Gold Coast are conducted not by administrative subdivisions of the Country, which are in a state of considerable flux, but by natural geographical regions. The reasons for this are contained in the paper under reference.

Since the Goma Conference, formal soil surveys have been undertaken of the following natural geographical regions:-

Ayensu basin, 720 sq. miles, Detailed Reconnaissance Survey,

Accra plains, 1,500 sq. miles, Reconnaissance Survey,

Kpong Pilot Irrigation Area, $1\frac{1}{2}$ sq. miles, Detailed Survey,

whilst work is nearing completion on the following:-

Upper Tano basin, 3,600 sq. miles, Detailed Preliminary Survey,

Kumasi region (basins of the Ofin and Oda) 3,350 sq. miles, Detailed Preliminary Survey.

The significance of the terms, Preliminary, Reconnaissance and Detailed Survey has already been given by Charter (1, 2). Owing to the fact that Detailed Reconnaissance Surveys supply far more information than can be dealt with by staff with the experience now available, the method of Detailed Preliminary Survey has been adopted. This method consists in the production of soil association maps by a somewhat more thorough type of Preliminary Survey than that already described (1, 2), giving a coverage equivalent to that provided by parallel traverse lines 5 miles (8 Kilometres) apart whilst the detailed soil pattern within the associations is mapped by means of sample strips in the manner already described (1, 2). It is planned to cover the whole of the Gold Coast, 91,843 sq. miles, by this method by the end of the second Five-Year Plan in March, 1961.

The work on the Kpong Pilot Irrigation Area on the Accra plains was carried out in considerable detail using a one-chain (20 metre) grid and has a significance far greater than the dimensions of the area suggest. This area is situated on Tropical Black Earths and is representative of 300 sq. miles of similar soils most of which will be irrigable when the Volta dam is constructed; further, it will supply information on the treatment under irrigation of some 280 sq. miles of other heavy clay soils on the Accra plains.

*April, 1948 to June, 1951, Soil Survey Division of Department of Agriculture; June, 1951 to date, Department of Soil and Land-Use Survey.

Publication of the reports on the Kpong Pilot Irrigation Area and on the Accra plains as a whole is under way. Other reports are in process of preparation.

As mentioned elsewhere (1, 2), during the various types of soil survey, surveys of the vegetation and of current land-use are also carried out, since the same traverses and cut-lines serve the purpose of all three kinds of survey, and vegetation and land-use data are needed, amongst other reasons, to interpret the soil findings. In surveying vegetation, the units established in Nigeria are employed (3, 4, 5); in land-use surveying the scheme approved for the World Land-Use Survey (6) has been employed. Vegetation and Land-use maps are available for all the areas at present covered by soil surveys.

In addition to the above, a 1: 500,000 scale compiled land-use map of the whole of the Gold Coast constructed from all data at present available and accompanied by an explanatory memoir is nearing completion.

Regarding vegetation, since approximately two-thirds of the Gold Coast is covered by tree savannah (or savannah woodland), on which grasses are the ecological dominants, particular attention is being paid to grassland formations. A large collection of local grasses and associated herbs have been collected for the Department's herbarium as a preliminary to this work.

At the commencement of soil survey work, much difficulty was experienced in obtaining senior staff. Lately, this situation has been greatly remedied. The total senior establishment of the Department of Soil and Land Use Survey comprises:-

Director
Senior Soil Scientist,
Senior Geographer,
2 Soil Analysts,
Compilation Officer,
Grassland Ecologist,
Crop Ecologist, and
10 Soil Survey Officers.

Of these posts only those of the Senior Soil Scientist, Senior Geographer and Crop Ecologist are vacant.

Since the major part of the Department's work consists of the mapping of distributions, its field staff has been largely recruited from geographers. In consequence of the newness of soil surveying in the tropics, a good deal of effort has, in the early part of an officer's work, to be expended in training.

Junior staff on the establishment of the Department comprises 87 salaried officers, 60 of whom are engaged on various technical duties in the field, laboratory and offices. Of approximately 170 daily-paid employees, about 110 are engaged on sub-technical duties mainly in the field and about 60 comprise semi-skilled manual workers such as engine and vehicle drivers, carpenters, etc. Between 170 to 200 labourers are employed when the Department is working

at full strength and these are recruited mainly in the areas being surveyed and are chiefly engaged upon line cutting.

As stated elsewhere (1), considerable importance is attached to locally-recruited personnel acquiring a knowledge of soil work. The provision of adequate training of junior officers and daily-paid employees has been difficult in the past due to a shortage of senior staff. Since the latter defect has been remedied, it has recently proved possible to place a soil survey officer in charge of a formal training scheme for both salaried and daily-paid employees.

Much effort has been expended during the period being reported upon in the construction and equipping of administrative and technical offices and of laboratories, stores and workshops. These are situated at Kwadaso, some six miles outside Kumasi, Ashanti, and comprise the following:- administrative, compilation, correlation and other technical offices, library, museum, routine laboratory, physico-chemical laboratory, carpenters', blacksmiths' and mechanics' shops, garages and a number of stores. The Department operates its own electricity, water and gas plants and runs and maintains its own transport.

The Department's laboratories, finally completed twelve months ago, are now very well equipped. Besides having all the general equipment for soil work they are provided in addition with apparatus for flame spectrophotometry and for the differential thermal analysis of clay minerals. Of these, the former is expected to be of great assistance in the rapid and accurate determination of soil nutrients. On March 31st this year, approximately 400 soil profiles had been analysed wholly or in part, comprising some 2,500 horizons, whilst a total of about 14,000 separate determinations had been carried out. The methods of analysis employed have been set out in some detail by Dr. de Endredy senior Soil Analyst of the Department, in reply to a questionnaire from the Inter-African Pedological Service, Yangambi (7). The Department's laboratories, besides being equipped to carry out soil work for purely agricultural purposes, is also in a position to carry out determinations on soils as foundation materials.

The Department's museum, besides housing the herbarium already mentioned, contains a reference collection of rocks, primary and secondary minerals and soil profiles. The soil profile collection numbers well over 2,000 and is representative of soils from all over the territory. One soil survey officer has been placed in charge of correlation to ensure uniformity of soil series determinations and of mapping.

Much attention has been paid to building up an efficient library with associated services. Few things are of such importance when carrying out research under tropical African conditions. At present, about 600 volumes are on the shelves and there are approximately 1,000 pamphlets and reprints. Fifty periodicals are subscribed to and documentation from overseas is provided by the Commonwealth Bureau of Soil Science, the Bureau Inter-africain des Sols and Aslib.

Whilst considerable progress has been achieved in supplying buildings and equipment for the technical work of the Department, it is disappointing to record that progress in providing accommodation for both senior and junior staff has been very slow.

In some quarters the amount of effort expended on the material basis for the Department's work may not have been properly appreciated. To carry out soil survey work in the underdeveloped parts of the tropics requires a well-equipped organization; further, mere field work alone, unsupported by laboratory determinations, is of very limited use. Without the substantial foundation for soil work such as the Department of Soil and Land-Use Survey has constructed during the past few years, really effective soil work under the conditions obtaining in tropical Africa is impossible. The Department's headquarters are shown on the accompanying photographs.

REFERENCES

1. Charter, C.F. 1949 Methods of soil survey in use in the Gold Coast. Communication No. 41, Comptes Rendus de la Conference Africaine des Sols, Goma (Kivu). Congo Belge. 1948. Bull. Agric. Congo Belge XL: 109-120
2. Charter, C.F. 1949 The detailed reconnaissance soil survey of the cocoa country of the Gold Coast. Report of the Cocoa Conference. London. 1949. The Cocoa, Chocolate and Confectionery Alliance, Ltd., London: pp. 19-23, 3 pl.
3. Jones, A.P.D. and Keay, R.W.J. 1946 Descriptive terms for the vegetation of the drier parts of Nigeria. Farm and Forest VII: 34-40.
4. Nigeria Forestry Department. 1948 The vegetation of Nigeria: Descriptive terms. Government Printer, Lagos.
5. Jones, A.P.D. 1945 Notes on terms for use in vegetation description in Southern Nigeria. Farm and Forest VI: 130-136
6. The World Land-Use Survey. Report of the Commission appointed by the International Geographical Congress, Lisbon, 1949.
7. de Endredy, A.S. 1954 Analytical methods used in the Gold Coast Department of Soil and Land-Use Survey. Bulletin No. 1, Gold Coast Department of Soil and Land-Use Survey, Kumasi.



Front view of the Department



Back view of the Department



View of the laboratory



View of the ancillary laboratory
buildings from the roof.



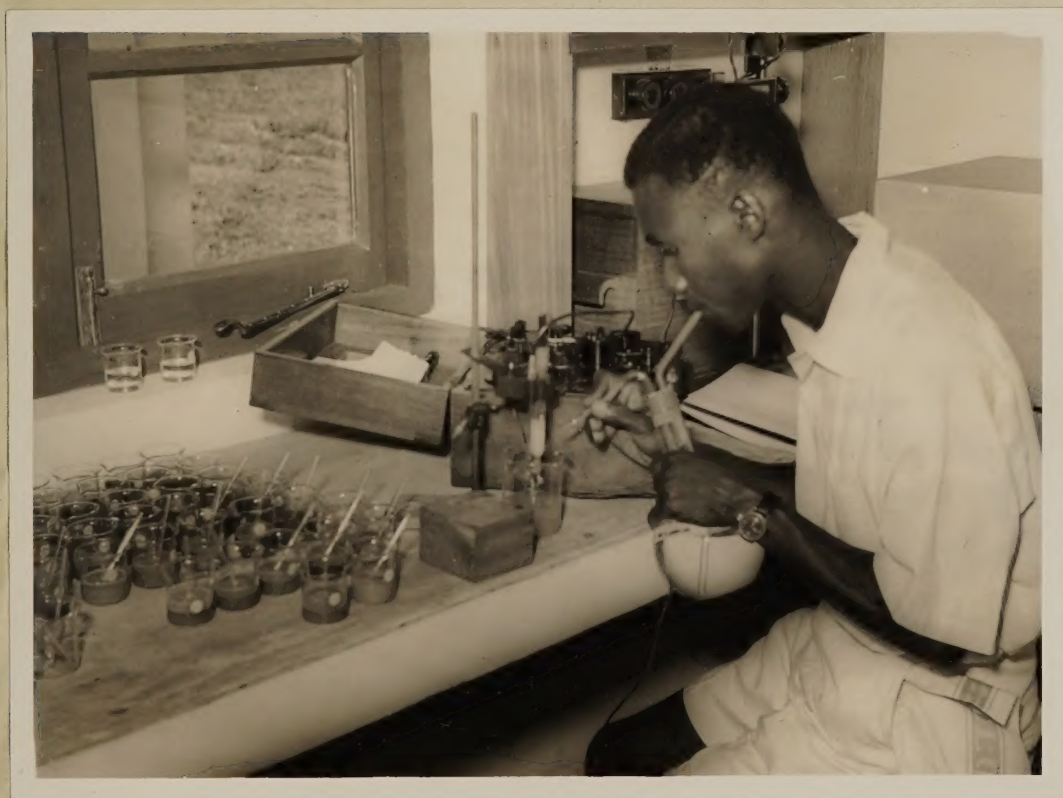
Laboratory: siphoning
off supernatant water



Laboratory: testing for CaCO_3



Laboratory: determination of
organic carbon



Laboratory: Delicate apparatus
room - pH testing

GOLD COAST DEPARTMENT OF SOIL AND LAND-USE SURVEY

MISCELLANEOUS PAPER No.2

ANSWERS TO THE QUESTIONNAIRE SUBMITTED BY THE INTER-
AFRICAN PEDOLOGICAL SERVICE, YANGAMBI, BELGIAN CONGO,
IN PREPARATION FOR THE C.C.T.A. INTER-AFRICAN SOILS
CONFERENCE, LEOPOLDVILLE, 1954.

KUMASI
May, 1954

Inter-African Pedological Service
Yangambi,
Belgian Congo

Gentleman,

The Council of the Inter-African Pedological Service gave its approval to the following items of the proposed working programme at its meeting at Yangambi on October the 20th and 21st, 1953.

One subject to be continuously studied by the Service is the establishment and keeping up to date of a pedological map of Africa south of the Sahara. This task shall be carried out with the collaboration of interested pedologists working in Africa and should normally lead to the adoption of a common system of soil nomenclature and classification. May I remind you that this is one of the principal aims of our Service according to the second recommendation of the 1948 Goma Conference.

The following items were specifically mentioned in connexion with the 1954-1955 programme:

- I) Pedological cartography of Africa.
 - a) Analysis of concepts and methods to be employed in setting up pedological maps of Africa south of the Sahara;
 - b) Comparison of these methods;
 - c) Correlation of different taxonomical units;
 - d) Study of the grading of tests for classifying these units.
- 2) Comparative study of various methods of analysis used in pedological laboratories and their possible application to the different pedological units.
 - a) The undertaking, in collaboration with the various services concerned, of a comparative study of existing methods of operation;
 - b) Collecting the opinions of different research workers concerning methods of operation;
 - c) The establishment of an order of priority for the comparative study of the methods in question and the contacting of persons whom it is necessary to consult in this connexion.
- 3) Preparation of the Inter-African Soils Conference to be held at Leopoldville in August, 1954.

x
x x

On the occasion of this Conference, I believe that it would be of interest to present a first draft of the pedological map of Africa. It would thus be possible to obtain a comprehensive view of the data that have been gathered and attention would be drawn at the same time to any lacunae that might exist. The comparison of different ideas on African pedological cartography would be facilitated and this would no doubt lead to fruitful discussion.

With a similar aim, I should also like to collect certain information concerning methods of analysis used in various laboratories where African soils are studied.

A compilation of methods of operation used at present in the Agrology Section of the I.N.E.A.C. at Yangambi will be forwarded you soon, by the good offices of the Inter-African Bureau for Soils and Rural Economy, Paris. The same Bureau has already furnished you with a similar compilation established by Mademoiselle Belay entitled "Analysis protocols for tropical soils". The latter work was published in "L'agronomie tropicale", Vol. III, 1953, pp. 307-323.

May I request you kindly to study these two documents, to compare them with the methods that you yourself use, and to forward me your observations.

In order that study of the various points of my programme may be commenced at once, I am also enclosing the questionnaire that you will find herewith, and beg you to be kind enough to answer it at your earliest convenience.

It goes without saying that no document received will be circulated, even in part, to the scientific world or to a restricted number of persons, without explicit mention of its source and author.

Dr. J. D'Hoore

Director of the S.P.I.

QUESTIONNAIRE

A. Questions of a general nature.

- 1) Do you believe that the enclosed distribution list should be completed or corrected ?
- 2) What are the names, qualifications and specialities of the different pedological research workers of your Service ?
- 3) What geographical region comes under your Service ? On what geographical regions could you eventually give us pedological information ?
- 4) Could you furnish us with a list of pedological publications issued by your Service and, eventually, with offprints ?

B. Pedological cartography of Africa.

- 1) What pedological maps are available in your territory ? Please specify whether they are general or detail maps. What is their scale, for what purpose were they established ?
- 2) Do these maps include explanatory notices ?
- 3) Have any of these maps been published ? Could you furnish us with a copy ?
- 4) What maps are in course of establishment by your Service ?
- 5) Is there a publication containing descriptions of the method of prospection used in establishing these maps ? Please give references if such is the case. If not, could you briefly describe the method used ?
- 6) What are the tests, listed in order of importance, that you use to distinguish your taxonomical units when working in the field ?
- 7) What are the principal analyses that you have carried out in the laboratory in view of making the above-mentioned distinctions ?
- 8) What great soil groups are you able to distinguish in your region ? Can you give us their principal characteristics ?
- 9) Could you furnish us in the near future with a distribution map of the great soil groups in your region ? Please specify if representation is schematic or in greater detail.
- 10) Have you used any of the following publications for the study of the great groups ? If not, what data have you used as a basis ?

- Shantz H.L. et Marbut C.E. The vegetation and soils of Africa.
Am. Geogr. Soc. New York 1923.
- Van der Merwe C.R. Soil groups and subgroups of South Africa
Dept. Agr. S.Africa Sci. Bull. 231 pp 1-316
- Kellogg C.E. et Davel F.D. An exploratory study of soil groups in the Belgian Congo
INEAC Brussels Serie Scientifique No 46 1949.
- Aubert G. Les sols de France d'Outre-Mer.
Imp. Nationale Paris 1941.
- Aubert G. et Fournier F. Lettre aux pedologues No 7 (1953)
Texte stencile, Office de la Recherche Scientifique Outre Mer (ORSOM) Paris.
- Middelburg A. Classification des sols tropicaux et subtropicaux. Rapport presente a la section des sols tropicaux et subtropicaux du IVeme Congres international de la Science du sol a Amsterdam, 1950.

C. Comparative study of various methods of analysis used in pedological laboratories and the possibilities of their application to various pedological units.

1. What is the principal activity of your laboratory ?
Research with a view to cartography,
Research dealing with fertility,
"Routine" research or analyses.
2. What methods of operation do you habitually use ?
In the case of published methods please give bibliographical references.

Adapted methods,
New methods,
Please indicate, for each method, the purpose or aim and the type of soil for which it is used.
3. Can you specify any methods of operation in current use for soils of temperate regions but which do not give satisfaction for certain African soils ?

ANSWERS TO THE QUESTIONNAIRE SUBMITTED BY
THE INTER-AFRICAN PEDOLOGICAL SERVICE
YANGAMBI, BELGIAN CONGO.

A. Questions of a general nature.

1. Do you believe that the enclosed distribution list should be completed or corrected ?

Unanswerable; distribution list not enclosed.

2. What are the names, qualifications and specialities of the different pedological research workers of your Service ?

NAME	QUALIFICATIONS	POST OCCUPIED	SPECIALITIES
CHARTER, C.F.	M.A. (Cantab.)	Director	
BRAMMER, H.	M.A. (Cantab.) ¹	Soil Survey Officer)	
PHILP, R.R.	M.A. (Aberdeen) ¹	- do -	
RADWANSKI, S.A.	B.A. (Cantab.) ²	- do -	Soil Surveying
HOTSON, J.McG.	M.A. (Edin.) ¹	- do -	
CROSBIE, A.J.	M.A. (Aberdeen) ¹	- do -	
PURNELL, M.F.	B.A. (Oxon.) ¹	- do -	
MOULD, A.W.S.	B.Sc. (Durham) ³	- do -	
AHN, P.N.	B.A. (Cantab.) ¹	- do -	
STOBBS, A.R.	B.Sc. (Durham) ¹	- do -	
BRASH, H.T.(MISS)	B.A. (Cantab.) ¹	- do - (i/c Correlation)	Geomorpho- logy & soils
WILLS, J.B.	B.A. (Cantab.) ¹	Compilation Officer	Cartography & Records
de ENDREDY, A.S.	Ph.D.(Budapest) ⁴	Soil Analyst	Soil Analysis
MONTGOMERY, C.W.	M.A. (Cantab.) ⁴	- do -	

1. Geography, 2. Agriculture, 3. Geology, 4. Chemistry.

3. What geographical region comes under your Service ?
On what geographical regions could you eventually
give us pedological information ?

(a) The Gold Coast, including the Colony, Ashanti and the Northern Territories and that part of Togoland under United Kingdom Trusteeship.

(b) For the above specified territories.

4. Could you furnish us with a list of pedological publications issued by your Service and, eventually, with offprints ?

A list of the Department's publications is given below.

Reprints could be supplied eventually.

By C.F. Charter:-

- (a) 1947 Cocoa soils good and bad. West African Cocoa Research Institute (Cyclostyled). 11 pp., 4 plates.
- (b) 1949 Methods of Soil Survey in use in the Gold Coast. Communication No. 41, Comptes rendus de la Conference Africaine des Sols, Goma (Kivu), Congo Belge. Bull. Agric. Congo Belge, XL, 1, pp. 109-120
- (c) 1949 The organization of Soil Survey in British West Africa. Communication No. B(g) 9. African Regional Scientific Conference, Johannesburg, Vol. II State-ments and Communications. Government Printer, Pretoria. pp. 103-108.
- (d) 1949 The detailed reconnaissance soil survey of the cocoa country of the Gold Coast. Report of the Cocoa Conference, 1949. The Cocoa, Chocolate and Confectionery Alliance Ltd., London. pp. 19-23, 3 plates.
- (e) 1949 The characteristics of the principal cocoa soils. Ibid. pp. 105-112, 1 plate.
- (f) 1953 The need for manuring cocoa in the Gold Coast in order to maintain and augment the level of production. Report of the Cocoa Conference, 1953. The Cocoa, Chocolate and Confectionary Alliance, Ltd. pp. 145-147, 2 plates;

by Brammer, H. and de Endredy, A.S.:-

The Tropical Black Earths of the Gold Coast and their associated Vlei soils. Paper being presented at the Fifth International Congress of Soil Science, Leopoldville, 1954;

by Brammer, H.

- (a) Detailed soil survey of the Kpong pilot irrigation area. In course of publication.
- (b) Reconnaissance soil survey of the Accra Plains. In course of publication;

by de Endredy, A.S.

The organic matter content of Gold Coast soils. Paper being presented at the Fifth International Congress of Soil Science, Leopoldville, 1954;

by de Endredy, A.S. and Montgomery, C.W.

Some nutrient aspects of Gold Coast forest soils. Paper being presented at the Fifth International Congress of Soil Science, Leopoldville, 1954.

B. Pedological cartography of Africa.

1. What pedological maps are available in your territory? Please specify whether they are general or detailed maps. What is their scale, for what purpose were they established?

Detailed Soil Maps (i.e. maps showing soil series).

Detailed soil maps are available for the land of the West African Cocoa Research Institute (1:2,500 and 1:5,000), of several agricultural experimental stations (1:6,250) and of a large number of sample strips, each with an expanse of 160 acres (1:7,920).

General Maps (i.e. Maps showing soil associations, etc.)

These cover approximately 3,700 square miles and are on a scale of 1:125,000 and 1:250,000.

The detailed soil maps were prepared to assist agronomic investigations; the general maps have been made in order to prepare an inventory of the territory's soil resources and to assist extension and development work.

2. Do these maps include explanatory notices? Memoirs or bulletins to accompany some of the maps have been prepared. Others are in course of preparation.
3. Have any of these maps been published? Could you furnish us with a copy?

Two maps of the West African Cocoa Research Station have been printed. Maps of other areas are in course of preparation.

Copies of these maps can be furnished when printed.

4. What maps are in course of establishment by your Service?

General maps of the Upper Tano basin (3,600 sq. miles) and of the Kumasi region (3,350 sq. miles) on the scale of 1:125,000.

5. Is there a publication containing descriptions of the method of prospection used in establishing these maps? Please give references if such is the case. If not, could you briefly describe the method used?

Accounts of the methods used by this Department have already been published as under:-

1. Charter, C.F., 1949. Methods of soil survey in use in the Gold Coast. Communication No. 41, Comptes rendus de la Conference Africaine des Sols, Goma (Kivu), Congo Belge. Bull. Agric. Congo Belge, XL, 1, pp. 109-120.
2. Charter, C.F., 1949. The detailed reconnaissance soil survey of the cocoa country of the Gold Coast. Report of the Cocoa Conference 1949. The Cocoa, Chocolate and Confectionery Alliance Ltd., London, pp. 19-23, 3 plates.

In course of preparation:-

Hotson, J.McG. Method of detailed soil survey of sample strips.

The present method of survey employed for the overall soil survey of the Gold Coast is termed Detailed Preliminary Soil Survey. Soil associations, etc. are mapped by the method of preliminary survey, (cf. publications listed above), whilst the soil pattern within associations, etc. is mapped over sample areas of 160 acres by the methods of detailed survey, (cf. publications already referred to).

It may be noted that at the same time that soil surveys are carried out vegetation and land-use surveys are made using the same traverses. The land-use surveys are being carried out in conformity with the World Land-Use Survey. (cf. The World Land-Use Survey. Report of the Commission appointed by the International Geographical Congress, Lisbon, 1949).

6. What are the tests, listed in order of importance, that you use to distinguish your taxonomical units when working in the field ?

The criteria used to distinguish taxonomical units when working in the field are given below. It is difficult where the majority of criteria are concerned, to assert that one is of more importance than another.

- i. Topographic form of which the soil expanse forms a part, including relief and drainage.
- ii. Vegetation, natural or semi-natural.
- iii. Parent material and its mode of origin.
- iv. Profile characteristics: no. of horizons present and for each horizon recognised:-
 - (a) depths between which they occur;
 - (b) colour (Munsell notation used);
 - (c) content of organic matter, based on colour;
 - (d) texture, based on manipulative test;
 - (e) consistency;
 - (f) structure;
 - (g) reaction by colorometric method;
 - (h) presence or absence of CaCO_3 (dilute HCl);
 - (i) presence or absence of soluble salts (AgNO_3 , BaCl_2);
 - (j) presence or absence of MnO_2 (dilute H_2O_2);
 - (k) presence or absence of ironstone concretions and pan;
 - (l) presence or absence of stones, gravel, etc.

7. What are the principal analyses that you have carried out in the laboratory in view of making the above-mentioned distinctions ?

In common with a number of other soil surveys, this Department differentiates soils for mapping purposes solely on the basis of their field characteristics.

Laboratory data are employed in further characterizing them for the purposes of formal description. In addition, analytical work is performed in order to provide information with respect to their nutrient status in relation to crop growth. Soils found to be distinct on the basis of field characters have been found equally distinct on the basis of laboratory analyses.

8. What Great Soil Groups are you able to distinguish in your region. Can you give us their principal characteristics?

Red Earths, Yellow Earths, Grey-brown Red Earths, Grey-brown Yellow Earths, Solonchaks, Solonetz, Humic-Glei soils, Bog soils, Half-Bog soils, Low-Humic Glei soils. Planosols, Groundwater Laterite soils, Groundwater podzol soils, Rendzina soils, Lithosols, Regosols, Alluvial soils, Tropical Black Earths and Vlei soils.

The Red and Yellow Earths and the Grey-brown Red and Yellow Earths are soils termed 'Latosols' by American soil workers. Relatively few Red and Yellow Earths occur in the Gold Coast; the major proportion of the well-drained upland soils are Grey-brown Red and Yellow Earths having a dark grey-brown, often almost black when wet, surface horizon which tends to be nearly neutral in reaction or occasionally even slightly calcareous (concretions from the trunk of Chlorophora excelsa and mollusc shells Achatina fullica). These soils would appear to be similar to the Black-Red Latosol of Kellogg and Daal described from the Belgian Congo.

Groundwater podzols are probably rare but Groundwater laterites are very extensive. Rendzinas are very localized. Tropical Black Earths and Vlei soils have been described in a recent paper by members of this Department, (cf. answer to question A 4.)

The characteristics of the other great soil groups are as set out in: Thorpe, James and Smith, Guy D., 1949. Higher Categories of soil classification: order, suborder, and Great Soil Groups. Soil Sci. 67 pp. 117-126.

9. Could you furnish us in the near future with a distribution map of the great soil groups in your region? Please specify if representation is schematic or in greater detail.

A provisional map of the Great Soil Groups of the Gold Coast has been prepared for inclusion in the forthcoming edition of the Gold Coast atlas and can be supplied when printed. This map is schematic: it not being possible to prepare a more detailed and accurate one until the overall survey of the country is completed.

10. Have you used any of the following publications for the study of the great groups? If not, what data have you used as a basis?

All of the publications listed are in the Department's library with the exception of Aubert G., Les sols de France d'Outre-Mer. Imp. Nat., Paris, 1941, which appears difficultly obtainable.

- C. Comparative study of various methods of analysis used in pedological laboratories and the possibilities of their application to various pedological units.

1. What is the principal activity of your laboratory ?
Research with a view to cartography, research dealing
with fertility, and routine research or analyses.

This Department does not believe in cartography executed on the analytical bench. Its position is made clear by the answer given to Question B.7. Apart from analyses designed to supplement soil data obtained in the field for descriptive purposes, laboratory work is undertaken in connection with fertility determinations and with soils as foundation materials.

2. What methods of operation do you habitually use ?
In the case of published methods please give
bibliographical references.

Adapted methods

New methods

Please indicate, for each method, the
purpose or aim and the type of soil
for which it is used.

This question has been answered in detail by Dr. de Endredy, senior Soil Analyst, in Bulletin No. 1: Analytical Methods used in the Gold Coast Department of Soil and Land-Use Survey. 1954. (Cyclostyled).

3. Can you specify any methods of operation of current
use for soils of temperate regions but which do not
give satisfaction for certain African soils.

All of the methods used in this Department's laboratories were designed for use with temperate soils; no instances have been found where they were unsatisfactory for use with Gold Coast soils. However, where fertility determinations are concerned their significance is sometimes doubtful due to the little that is known regarding the limits of adequacy for most tropical crops.

ANALYTICAL METHODS USED IN THE LABORATORY OF THE
GOLD COAST DEPARTMENT OF SOIL AND LAND-USE SURVEY.

By

A.S. de Endredy, Soil Analyst

All analyses are carried out on the 'fine earth' fraction e.g. the fraction passing the 2 mm. sieve. It may be noted, however, that according to C.F. Charter (1) it may on occasions be necessary to consider the use of a coarser fraction of soils containing much fine gravel, because in such soils the encrusting soil material contributes considerably to the active fraction of the soil. The question will be investigated in the future.

Two routine courses of analysis are followed: one designed to meet the requirements of a complete description of typical profiles and the other to meet the demands of a quick assessment of the soil as a growing medium. The two courses are termed 'detailed description' and 'general description', respectively. In the 'detailed description' the following analyses are carried out: separation of coarse material, determination of colour, particle-size distribution of the fine earth according to the international scale, CaCO_3 , organic carbon, nitrogen (C/N ratio calculated), pH, exchange complex comprising cation exchange capacity, exchangeable Ca, Mg, Mn, K and Na, water soluble salts (chlorides, bicarbonates, sulphates), acid-soluble phosphorus (Truog method), total phosphorus, manganese peroxide (where needed), hygroscopic moisture at 50 per cent. humidity, ignition loss and, whenever warranted, plastic limit, liquid limit and plastic index. In the 'general description' the coarse material is determined as above, as well as the colour, but for the particle-size distribution and abbreviated method is used; the organic matter and nitrogen are estimated as before; the reaction is determined, but the analysis of exchange complex is generally limited to the estimation of cation exchange capacity, exchangeable Ca and K. Soluble salts are determined only in saline soils. Only the soluble phosphorus is determined for purposes of general description.

DETAILS OF THE METHODS

Preparation of the soil sample and separation of the coarse fraction:

This is identical for both the 'detailed' and 'general' course and it is carried out according to Piper (2). The following coarse fractions are separated by dry sieving: Stones (retained on the 20 mm. sieve), coarse gravel (retained on the 6.25 mm. sieve), fine gravel (retained on the 2 mm. sieve) and fine earth (passing the 2 mm. sieve). The coarser fractions are washed and the approximate mineral composition of each fraction determined (e.g. quartz, ironstone concretions, unweathered rock, calcareous concretions, etc.).

Colour:

This is determined by comparing the air-dry soil and the same soil wetted to the plastic limit with the Munsell colour charts (3) and both the Munsell notation and the description of the colours reported. Naturally the same method is used in both the 'detailed' and 'general' analyses.

Particle-size distribution of the fine earth:

For the purpose of 'detailed description' the beaker method of analysis, as described by Piper (4) has been used, with the difference that the international 'coarse sand' (2 - 0.2 mm.) has been separated into two fractions 2 - 0.625 to 0.2 mm. The former is called 'very coarse sand'. If attention is paid to the proper destruction of organic matter (and prior to that, of course, to the removal of the manganese peroxide present), the method is suitable for the entire range of soils occurring in the Gold Coast. For the purpose of the general description, an abbreviated beaker method has been elaborated upon the suggestion of C.F. Charter. In this method, the sample is treated in exactly the same way as in the preparation for the beaker method, except that the clay and silt are decanted together, the decantations rejected and the remaining fine sand weighed. The coarse sand is removed in a previous operation, as in the beaker method. Knowing the organic matter and CaCO_3 content of the sample, the amount of silt plus clay equals 100 less the sum of organic matter, CaCO_3 coarse sand and fine sand. The method is not accurate, but it furnishes information adequate for comparative purposes.

NOTE: It is expected to introduce the hydrometer method, as outlined in British Standard 1377: 1948 (33), for mechanical analysis for the purpose of general description, using sodium hexametaphosphate as a dispersing agent (commercially known as 'Calgon'). Some experiments done by de Endredy (5) indicate that sodium hexametaphosphate is a very satisfactory dispersing agent for soils containing montmorillonitic clay and either nil or considerable amounts of CaCO_3 , but the suitability of 'Calgon' for dispersing ferruginous soils has yet to be tested. CaCO_3 : the original Scheibler-Passon method is used, because experiments showed that the use of the elaborate Collins calcimeter (6) has no advantages. For control purposes the usual gravimetric method for the determination of CO_2 is used (7), employing perchloric acid instead of hydrochloric.

Note: The method of Tinsley (8) may be very useful for the accurate determination of $\text{CaCO}_3(\text{CO}_2)$ in soils.

Organic carbon and organic matter

The method of Walkley-Black as described in Piper (9) proved itself generally applicable to all soils in the Gold Coast. The recoveries wet vs. dry combustion are, however, different for different soils and have been partly investigated (10). However, as sufficient data for separate conversion factors for all soils are not yet available the general factor assuming 77 per cent. recovery is used for the calculation of all results. (1 ml. N $\text{K}_2\text{Cr}_2\text{O}_7$ = 3.9 mg. C). The organic matter is obtained by multiplying the organic C present with 1.72.

Total Nitrogen.

The Kjeldahl method is used, employing selenium-potassium sulphate as a catalyst. The results are satisfactory in all soils, including the heavy Black Earths of the Accra Plains. The carbon/nitrogen ratio is calculated from the organic carbon computed on the 77 per cent. recovery basis.

Reaction (pH)

This is determined by the glass electrode, using a soil water ratio of 1:1.

Exchange Complex

Although the methods employed in our laboratory are mostly compilations from generally used procedures, they have been revised and modified according to our requirements, based upon original investigations carried out here. It appears to be justified, therefore, to describe the methods in some detail. N neutral ammonium acetate is

employed as a leaching solution for the determination of the cation exchange capacity and all exchangeable bases for soils containing up to 2 per cent. calcium carbonate and N potassium chloride for the determination of exchangeable calcium in soils having more than 2 per cent. CaCO_3 .

Determination of cation exchange capacity and exchangeable bases, ammonium acetate method

Two courses of analysis have been adopted, one to meet requirements of the 'detailed description' and the other for 'general description'. In the procedure for 'detailed description' two 10-g. portions of the fine earth are weighed separately into 100 ml. beakers and each treated with 50 ml. of the ammonium acetate solution. Next day the supernatant liquid is decanted through a $12\frac{1}{2}$ cm. Whatman No. 2 filter, taking care to transfer as little soil as possible to the filter (11). Fresh portions of ammonium acetate solution are now added and the leaching is generally continued until about 350 ml. of the filtrate is collected. If more than 0.2 per cent. CaCO_3 is present, the leaching of one portion is continued until a second 350 ml. of the filtrate is collected, in order to ensure complete removal of calcium carbonate. The second filtrate is received in a separate vessel. The Ca is determined in both portions and if more than 2 m.e. Ca have been found in the second leachate a fresh portion is leached with three 350 ml. aliquots of 350 ml. ammonium acetate solution. If it is known in advance that the soil contains over 1 per cent. CaCO_3 , the first leaching should be continued until about 700 ml. of the filtrate is collected when the receiver is changed and a second portion of about 350 ml. is collected in order to test the complete removal of CaCO_3 . (12). The second portion of soil, serving for the determination of exchangeable K, Na and Mn, is leached with only 350 ml. ammonium acetate solution. The filtrates are evaporated to dryness on the water-bath and the residues treated according to Peech (13) to remove ammonium salts and organic matter. The ignited residue of the portion (or portions) serving for the determination of Ca is (are) taken up in 2 ml. 6N HCl and 20 ml. water and

/filtered ...

5.

filtered into a 100 ml. volumetric flask (flasks), using 0.1 N HCl for rinsing and washing. This portion is designated as Solution A (Sol. A₁ and A₂, respectively in case the amount of calcium carbonate necessitated obtaining two leachates). The second portion is dissolved in 10.00 ml. of 0.1N nitric acid added with a pipette and this solution is designated as Solution B.

For the determination of cation exchange capacity, the leaching of both portions of soil remaining on the filter and in the beakers is continued with 90 to 95 per cent. ethyl alcohol, until about 200 to 250 ml. of the filtrate is collected. The filtrate is rejected and the soil in the beaker and on the filter is transferred to a distilling flask and the adsorbed ammonia distilled off after the addition of 50 ml. of N sodium hydroxide. The distillate is received in 50 ml. of a 4 per cent solution of boric acid and the ammonia titrated with 0.1 N HCl, using a mixed indicator with a pT = 5.1 (14). The average of the two determinations is taken as the cation exchange capacity.

For the determination of Ca and Mg, 50 ml. of the Solution A is precipitated with bromine water and ammonia in order to remove iron, aluminium and manganese and in the filtrate from the mixed hydroxides the calcium is precipitated as calcium oxalate according to Winkler (15) and after filtration titrated with 0.05 N KMnO₄. The filtrate of calcium oxalate is treated with some sodium metabisulphite to remove traces of oxidants and the Mg precipitated as the 8-hydroxyquinolate and weighed as Mg. (C₉H₆ON)₂.[ⓧ]

If two Solutions A (A₁ and A₂) have been collected, as in the presence of calcium carbonates, the Ca must be determined separately in each aliquot in order to check complete leaching of CaCO₃ (see above). As to the Mg it is

/quite ...

[ⓧ] The reduction of the solutions by Na₂S₂O₅ prior to the precipitation of Mg prohibits the formation of dark condensation products, which would make the determination inaccurate, particularly when only little Mg is present.

quite exceptional to find any appreciable amount of Mg in the second filtrates, thus the determination of Mg in the second filtrates can be omitted. The amount of Ca found in both solutions A must be added and the equivalent amount of Ca corresponding to the CaCO_3 present must be deducted from the sum in order to find the true amount of exchangeable Ca (CaCO_3 per cent. $\times 20 = \text{m.e. Ca}$ to be deducted).

In the remaining 50 ml. of Solution A the sulphates are precipitated as BaSO_4 , filtered, ignited and weighed.

For the determination of K, Na and Mn, Solution B is transferred into a 15 ml. centrifuge tube and the silica thrown down by centrifuging for 10 minutes at 3,000 R.P.M. (16). From the clear supernatant liquid 5 ml. is pipetted for the determination of potassium. Potassium is determined by a method based on that of Piper (17) and modified by de Endredy (18). Ceric sulphate and ferrous sulphate are used for the titration. Another 2 ml. aliquot is used for the determination of sodium by the method of Alten and Weiland (19). We prefer the latter procedure to that suggested by Kahane (20), because it is less affected by the presence of potassium, sulphates and phosphates. Finally a last 2 ml. aliquot is used for the determination of exchangeable manganese, using potassium periodate to convert Mn to MnO_4 .

In the procedure for 'general description' only one 10 g. portion of the soil is leached. If CaCO_3 is present, the leaching is continued to obtain a second filtrate, as before. After the expulsion of ammonium salts and destruction of organic matter, however, the residue is dissolved in 10.00 ml. 0.1 N nitric acid. When a second filtrate has been obtained, this is also separately dissolved in 10.00 ml. of 0.1 N nitric acid. The solutions are centrifuged and 5 ml. is pipetted for the determination of K, as above. The Ca is determined in a 2 ml. portion according to the semi-micro procedure of Winkler (21) and titrated with 0.02N KMnO_4 . In the presence of CaCO_3 , when a

second filtrate has been obtained, only the Ca is determined in the second portion and the amount of exchangeable calcium is calculated by summing the two aliquots and deducting the amount equivalent to the CaCO_3 present. Finally, if required, the exchangeable Mn is determined in a 2 ml. aliquot.

The 'general description' procedure, of course, is less accurate in respect of the determination of Ca and its use is restricted to the highly leached soils of the forest zone containing comparatively small amounts of Ca. However, it gave very good results when used tentatively on the heavy clay soils of the Accra Plains which have an exchange capacity of 60 to 70 m.e. per cent. and contain up to 30 m.e. exchangeable Ca.

Determination of exchangeable Ca in calcareous soils containing more than 2 per cent. CaCO_3 .

The well known method of Hissink (22) is used, but employing N Potassium chloride instead of sodium chloride. Unpublished investigations of de Endredy revealed that more uniform results are obtained by using KCl and that the filtration is incomparably faster.

Water-soluble salts

In the 'general description' the conductometric method (23) is used. When a more detailed determination is required, a water extract (1 soil to 5 water) is analysed (24). The cations are determined as outlined above, while HCO_3 is determined by titration with standard HCl and the Cl^- by titration with standard silver nitrate (25). If appreciable amounts of gypsum are present, they are calculated from the SO_4^{--} , determined in the ammonium acetate extract.

Final calculation of the exchange complex

This refers naturally only to detailed analysis. If soluble salts are absent, the sum of the exchangeable Ca, Mg, Mn, K and Na represents the total of the exchangeable bases. The difference between the cation exchange capacity and the total gives the approximate amount of exchangeable hydrogen and we found that this amount usually agreed well with the exchangeable hydrogen directly determined by the barium acetate method of Mehlich (26). In neutral

and alkaline soils containing no salts the total of the exchangeable bases should agree within ± 1 m.e. with the cation exchange capacity, provided that the amount of CaCO_3 present has been deducted from the total amount of Ca found in the analysis. However, we also observed some discrepancies in neutral and alkaline soils particularly in horizons containing weathering rock (27). We have also observed in soils containing 1:1 clay mineral that the cation exchange capacity tends to be lower than expected from the sum of the exchangeable bases and from consideration of the reaction (28).

The calculation of exchangeable cations in saline soils, particularly in those containing CaCO_3 is a very complicated question (29). For many purposes the following method leads to satisfactory results: the exchangeable bases and sulphates are determined by the 'detailed' procedure, and the water-soluble HCO_3^- and Cl^- are determined in a water extract. The amount of Ca found is corrected for the CaCO_3 present. The chlorides are accounted for as NaCl , the sulphates as Na_2SO_4 and the bicarbonates as NaHCO_3 . If the amount of SO_4^{2-} exceeds that of the Na remaining after the subtraction of NaCl , the remaining SO_4^{2-} is calculated as CaSO_4 . Similarly the bicarbonates are accounted for as $\text{Ca}(\text{HCO}_3)_2$, if insufficient Na is present. This method, although arbitrary, yields satisfactory results in soils containing less than 2 per cent. CaCO_3 . In more calcareous soils the direct determination of water-soluble salts is unavoidable or else some of the methods outlined by Kelley (30) must be used to calculate the exchange complex.

NOTE: The procedures described above are those used at present in this laboratory. We are, however, investigating flame photometry for determination of exchangeable bases, using the Hilger 'Uvispek' spectrophotometer and a hydrogen-oxygen flame.

Phosphorus acid-soluble

This is determined by the Truog method as described by Peech (31).

Phosphorus total

After digesting the soil sample with perchloric acid, the total phosphorus is determined by the method of Kitson-Mellon (32).

/ Manganese ...

Manganese peroxide

Peroxidic manganese is dissolved by treating the soil with sodium metabisulphite solution and determining the manganese spectrophotometrically.

Hygroscopic Moisture at 50 per cent. humidity

The weighed sample is equilibrated in vacuo over 43.4 per cent. by weight sulphuric acid and the water is determined by drying.

Ignition loss

This is determined by igniting a weighed amount of soil at about 800 C°. From the actual ignition loss found the amount of organic matter and carbon dioxide equivalent to the calcium carbonate present is deducted, yielding the corrected ignition "lost". This is quite closely correlated with the amount of clay present and serves as a check on the mechanical analysis.

Plastic Index

Plastic limit, liquid limit and plastic index are determined and calculated according to British Standard 1377: 1948. (33).

As can be seen from the above details, all the methods employed in this laboratory have been developed for soils of temperate regions. We have never encountered any difficulties in applying the methods. In our opinion, the difficulties are rather in the application of analytical results for practical purposes, e.g. in setting the limits of adequacy of plant nutrients, etc., but unfortunately very little, if anything, is known about this subject in relation to the common crops in the Gold Coast.

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DEPARTMENT OF SOIL & LAND-USE SURVEY, GOLD COAST

SOME NUTRIENT ASPECTS OF THE GOLD COAST FOREST SOILS

Paper submitted to the 5th International Congress of
Soil Science, Leopoldville, 1954.

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and

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1954

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DEPARTMENT OF SOIL & LAND-USE SURVEY, GOLD COAST

Summary:

A statistical examination of the data of 51 profiles from the central forest zone emphasises the accumulation of plant nutrients in the 2-3 inch thick surface horizon. The concentration of divalent bases, Ca, Mg and Mn is particularly conspicuous. K is concentrated to a lesser extent. Acid-soluble phosphorus also occurs predominantly in the surface horizon and a definite regression appears to exist between this category of phosphorus and the total nitrogen content.

Analytical:

Exchangeable cations were determined by the usual ammonium acetate method (1,2), using a modification of the sodium cobaltinitrite procedure of Piper for the determination of K (3). Soluble phosphorus was determined by the Truog method, using the procedure of Peech (1). Investigations in this laboratory showed that the method is suitable for soils containing less than 10 p.p.m. phosphorus, provided that a good photometer is used for measuring the transmittancies (4). Total nitrogen was determined by the Kjeldahl method and organic carbon by the usual wet combustion method of Walkley-Black.

The 'average' soil profile:

In order to obtain a reference basis for the statistical estimation, an average soil profile was constructed by calculating the means of the thickness of the first three morphological horizons from the data of 51 profiles (Table 1). From the average thicknesses the average weight of soil per horizon/per acre was calculated, assuming 1.2 for the dry density of the surface horizon and 1.6 for the lower horizons. The uniformity of the Grey-Brown Red and Yellow Earths^{*} is remarkable

/ Cation ...

* Nomenclature used for the more extensive upland soils of the high forest zone in this Department.

Cation exchange capacity, exchangeable calcium and potassium

Although the cation exchange capacity varied considerably in the 51 profiles examined, the ratio cation exchange capacity: organic carbon showed very little fluctuation in the surface horizon, indicating that the exchange capacity was practically a function of the organic matter. In the lower horizons the ratio increases and the values become more scattered, indicating the increasing share of the clay minerals in the exchange complex but the predominance of organic matter is still present in the second horizon (Table 2).

The exchangeable calcium covers also a wide range, but its distribution is more uniform. Calcium accumulates in the surface horizon and decreases rapidly towards depth. The amount occurring in the horizons below 20 inches do not differ significantly from the amounts found in the third horizon. A relative accumulation of Ca at the bottom of the profiles occurs but rarely.

The distribution of potassium is somewhat different. The accumulation of K in the surface horizon is general, but the depletion towards depth is less uniform, with the consequent narrowing of the Ca : K ratio towards depth. Accumulation in the deeper horizons is frequent and reflects the mineralogical composition of the parent material.

Exchangeable manganese, magnesium and sodium

The amount of data available does not permit a statistical examination as in the case of calcium and potassium. The available data, indicate, however, that the maximum amounts of magnesium and manganese occur in the surface horizon. In the lower horizons the amount of magnesium varies extremely, from nearly complete depletion to equivalence with or even predominance over calcium. Magnesium is more likely to accumulate towards the decomposing rock. The influence of the parent material on the occurrence of exchangeable magnesium is very pronounced. Granitic soils and soils over biotite schists are considerably richer in magnesium than soils developed over phyllites. The exchangeable manganese appears to be a complicated function of pH and organic matter and is usually localised in the upper horizons. The amounts range from 0.1 to 0.4 m.e. per cent. It is very characteristic that the deeper

/ horizons ...

horizons of the Grey-Brown Red and Yellow Earths in spite of their very acid reaction (pH 4.3 to 5.0), are nearly devoid of exchangeable manganese. This is possibly due to the good aeration and to the very low organic matter content of these soils. Finally sodium, although in minor quantities, e.g. 0.1 to 0.4 m.e. per cent., occurs regularly in the Grey-Brown Red and Yellow Earths and appears to be fairly evenly distributed throughout the profile.

Soluble phosphorus

Dot diagrams indicated a relation between the soluble phosphorus determined by the Troug procedure and the total nitrogen. Seventy-six surface horizon samples of the Grey-Brown Red and Yellow Earths and their associated soils yielded a significant regression between the two quantities. The regression equation is Y (soluble P p.p.m.) = $14.539 + 0.0287805$ (total N $\times 10^3 - 391.7$). The other data are as follows:

Mean N per cent. $\times 10^3 = \bar{X} = 391.7$, mean P p.p.m. = $\bar{y} = 14.539$; standard deviation of $\bar{y}$ (no regression considered) = 10.0259; standard deviation of $\bar{y}$ (regression considered) = 7.0303; Students 't' for $\bar{y} = a = 18.02$, for $b = 8.9495$ for $76-2 = 74$ degrees of freedom. For details of the calculations see Fisher (5).

Examining the cases of significant deviation it was revealed that the deviations are mainly positive and occur in soils having relatively high pH values around 7 and either contain some CaCO_3 or a relatively high amount of exchangeable Ca. High Ca obviously favours the accumulation of acid-soluble phosphorus but its presence does not necessarily increase the amount above the average.

In the lower horizons the interrelation between the soluble phosphorus and total nitrogen is still perceptible, but the small quantities occurring are influenced to such an extent by the analytical errors (± 1 p.p.m.) that a statistical examination would be valueless.

It may be mentioned that a relationship between the soluble phosphorus and total nitrogen was also observed by Robinson (6).

The average amount of plant nutrients in the forest soils

This was calculated from the results of 51 profiles (76 surface horizons for soluble P) and the quantities are expressed both in p.p.m. and lbs/acre, using the data given in Table 1 for the amount of soil in each horizon (Table 4). The figures accentuate the prominent rôle of the surface horizons as a source of nutrients. The accumulation of exchangeable calcium and soluble phosphorus is particularly emphasised. Bearing in mind, in addition, that the nutrients in the surface horizons are concentrated in a small volume of soil with water retention capacities far more favourable than those of the deeper layers, the importance of the surface horizons ~~and~~ with their included organic matter in the maintenance of the fertility of forest soils can be easily recognised. It should be considered, however, that while the exchangeable calcium represents the major part (if not the total) of the possible reserves, some potassium reserves may be expected in the form of difficultly-weatherable micaceous minerals in some soils, and that the soluble phosphorus is only a measure of the actual status, because reserves incomparably higher may be present in a form insoluble in dilute acids. This insoluble form, however, can possibly be made soluble by interaction with organic matter, which, in turn, again emphasises the importance of organic matter in the productivity of forest soils.

The above data refer mostly to soils of the central forest region of the Gold Coast, which are rather more acid (Table 5) than those supporting the greater part of the Colony's cocoa. Apart from the nearly complete lack of necessary agronomic information the data are averages and the variations in the individual profiles wide, consequently no attempts have been made to set up arbitrary 'adequacy limits' for either soils or crops.

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Table 1.

'Generalised' soil profile of the Grey-Brown
Red & Yellow Earths.

Average of 51 profiles

Horizon Depth inches	Horizon Thickness inches	Standard Deviation inches	Weight of soil in lbs/acre per horizon
0 - 2.735	2.735	1.106	744,363
2.735 - 8.409	5.674	2.229	2,059,001
8.409 - 19.752	11.343	6.065	4,116,191

Table 2.

Exchange complex in the average of 51 profiles

Horizon Depth inches	Cation Exchange Capacity m.e. per cent.	Organic C* per cent.	Ratio of organic C to exchange capacity	Exchangeable m.e. per cent.	
				Ca	K
0 - 2.735	18.539	5.0935	3.64	10.205	0.5504
2.735 - 8.409	7.196	1.6064	4.27	2.109	0.2478
8.409 - 19.752	5.912	0.6352	9.31	1.329	0.1957

* Wet combustion, not corrected for recovery.

Table 3.

Soils showing significant deviation from the regression:
acid-soluble P vs. total N (over twice the standard deviation)

Sample	Sign of Deviation.	pH	CaCO ₃ per cent.	Exchangeable Ca m.e. per cent.	Note
B 6	+	8.1	0.2	6.9	
B 10	+	6.3	Nil	25.2	
B 11	+	7.7	4.9	N.D.	
B 31	+	7.5	0.04	8.6	
B 184	+	7.7	Nil	19.0	
B 196	-	5.3	Nil	20.9	High organic matter
B 208	+	5.1	Nil	7.4	Alluvial soil

Table 4.

Plant nutrients in the average of 51 profiles*

Horizon Depth inches	CaO p.p.m.	CaO lbs/acre	K ₂ O p.p.m.	K ₂ O lbs/acre	Soluble P p.p.m.	Soluble P ₂ O ₅ p.p.m.	Soluble P ₂ O ₅ lbs/acre
0 - 2.735	2857	2127	259	160	14.539	33.31	24.8
2.735 - 8.309	590	1216	117	199	2.96	6.77	13.9
8.309 - 19.725	372	1532	92	315	1.78	4.09	16.8
Total for 0-19.752 inches		4875		674			55.5

* Based on the data in Table 1. For soluble P in the surface horizon the average of 76 profiles.

Table 5.

pH Class	4.0	4.1-4.5	4.6-5.0	5.1-5.5	5.6-6.0	6.1-6.5	6.6-7.0	7.1-7.5	7.6-8.0	8.0-8.5	Total
0-2.735	2	8	12	14	17	12	7	1	2	1	76
2.735-8.309	0	16	16	22	16	6	2	1	1	0	74
8.309-19.752	0	6	43	13	7	2	2	1	0	0	75

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ESTATE AGRICULTURE AND THE INTEGRATION
OF PEASANT FARMING

Memorandum to the meeting of the Executive Sub-Committee
of the Technical Advisory Committee for Agriculture and
Natural Resources, Accra.

12th May, 1954.

By

C.F. CHARTER

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ESTATE AGRICULTURE AND THE INTEGRATION OF PEASANT FARMING

I. INTRODUCTION

The traditional land policy in West Africa, in common with most of tropical Africa as a whole, has been 'to protect existing customary rights and to preserve native customs' (1). In the Gold Coast particularly, there has in the past been strong opposition to interference with peasant methods of crop production such as the introduction of plantation methods. The consequence has been that political and social progress has far outstripped technical advances in agriculture upon which the economy of the country will always be mainly based. Thus Professor Lewis (2) has declared that subsistence agriculture is stagnant and intimated that cocoa farming is retrograde. The anomaly presents itself therefore, of an almost independent state, the people of which are demanding a standard of living approaching that of industrial communities of mid-latitudes, expecting to support itself by an agricultural set-up practically neolithic in character.

It must be understood that extensive suffrage, national assemblies, cabinets, universal free elementary education, widespread secondary schooling, university colleges, hospitals, health services, etc. are amenities characteristic not of chaotic peasant communities but of industrial societies. If the amenities mentioned are to be successfully developed and maintained some measure of industrialization is necessary and, in a predominantly agricultural country such as the Gold Coast, some of this industrialization must be in the agricultural sphere, that is, to some degree estate agriculture employing all scientific and technical aids available must replace haphazard, fragmentary, crop production by traditional peasant methods.

It would, however, be absurd, even were it desirable, to suppose that the whole agricultural economy of the country could ever be converted from one of peasant production to one of estate production. Such a measure is not being proposed but merely that in time a relatively small proportion, say, one or two per cent. of the country, should be so affected. The considerable advantages it is deemed will follow this will be discussed later in this paper. However, if such advantages are to accrue, land utilization of the remaining area, though carried out by peasant farmers, must be efficiently integrated. This matter again is discussed fully later in this paper.

Radical improvement of Gold Coast agriculture is a matter of great urgency. The attainment of full responsibility for its own internal affairs has coincided with the approaching end of the Gold Coast's main natural resource upon which the prosperity of the country has hitherto depended. I refer here to the exhaustion of the virgin forest soils that can be expected in a decade or less. The effects of this as far as the cocoa industry is concerned I have discussed in my paper published in the 1953 Cocoa Conference Report (3); similar results will affect other forms of crop production, including subsistence farming. It would be disastrous were the Gold Coast's experiment in self-government to fail because it lacked the essential economic foundations.

It is not suggested that the proposals set forth in this paper can be implemented overnight or even in a decade or two. What is set out here is a programme of rationalized land-use for the Gold Coast, something to aim at year after year and decade after decade.

In 'trusteeship' days the reorganization of Gold Coast agriculture along the lines suggested would have been impossible and ridiculous to propose, but with the changes that have latterly taken place both in the world as a whole as well as in the political status of the Gold Coast itself such suggestions assume a wholly different character. Between the wars any attempt to introduce plantation agriculture would have smacked of foreign exploitation; now, however, with the Gold Coast people completely responsible for the internal government of their country no substantial objections can be raised to their inaugurating a measure of estate agriculture for their own economic improvement. It is already evident that this is realized locally whilst the content of Sir Geoffrey Olay's address to the 1953 Cocoa Conference shows that the principle is well appreciated by the Government of the United Kingdom. (3a)

To conclude this introduction and summarize its contents I quote from Chapter 13, The Attack on Backwardness, in Professor Macmillan's 'Africa Emergent' (4):- "Peasant agriculture, however well directed, cannot by itself suffice. Small-holdings can never reap the full benefit of the technical developments of scientific agriculture. Economic efficiency demands the use of estate methods, at least in some parts, to broaden the whole economic basis; but there is room for the combination of the two systems".

II. THE NEED FOR ESTATE AGRICULTURE

Agricultural production by estate methods is required for the following purposes :-

- (a) to provide facilities for research
- (b) to undertake the commercial production of commodities, particularly those not suited to production by small-scale peasant farmers
- (c) to demonstrate to small-scale peasant farmers efficient techniques in crop production.

The Provision of facilities for Research. At the present time our knowledge of tropical agriculture is inadequate for significant development; the results of a number of post-war schemes are sufficient evidence of this. In the Gold Coast facilities for field experimental work are very few and limited. Proper work cannot be carried out on farmers' small and transitory plots over which very little control can be exercised. Agricultural experiment stations are also too small for many purposes, for example, for work on perennial tree crops and on systems of subsistence farming. Besides, with units of this type it is frequently found that an inordinant amount of effort and time has to be devoted to maintaining the station as compared with the attention given to actual experimentation. What are required are large tracts of land under unified control and devoted to one type of agriculture. Estates would satisfy these conditions and relieve experimental staff of having to concern themselves with matters of maintenance. The majority of worthwhile experimental results in tropical agriculture have been obtained on commercial estates.

Commercial Production. Estate agriculture is necessary where crops are being processed at a local factory in order to guarantee an assured supply of the raw product so that the factory can operate continuously and efficiently. Sugarcane production is an example of this. An assured supply from estates may also be necessary when an export crop such as bananas is being produced so that extensive space in refrigerator vessels is not wasted. Similarly, where large-scale construction works are in progress estate agriculture could ensure

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the provision of adequate foodstuffs for the workers at reasonable prices. Estates may be more efficient producers of certain crops which call for techniques in advance of those familiar to unexpert peasant farmers.

The Demonstration of Improved Techniques. Estates can perform highly-important educational functions. They can serve as demonstrations of efficient agriculture, for farmers pay greater attention to what is being done by commercial concerns operating for profit than to the advice of government officials merely working for a salary. The methods and techniques estates employ are also spread through the medium of the labour and technicians they employ and train. The Gold Coast, in common with other British West African Colonies, has been unfortunate in not having any estate agriculture to exert such educative influences.

The value of Estate Agriculture for the employment of Africans with advanced technical education.

As has occurred everywhere throughout the world, the possession of education has resulted in a reluctance or an absolute refusal of the recipients to work on the land as peasant farmers. If those technically trained in secondary schools, technical colleges, and university colleges are to apply their technical and professional training to the development of agriculture estates employing specialists and technicians of various grades are absolutely necessary. Not all such people can be employed in government service and it would be a most unhealthy state of affairs if they could be. Estates, too, would provide attractive employment, and further training, for the large number of people with elementary education who, not wishing to be engaged in peasant farming, appear at present to have very little to do. The numbers of such can be expected to increase greatly in the years to come.

A happy and contented state consists of people with interesting jobs of work to do, not of people with all sorts of political and social privileges, many of them perhaps rather theoretical. A surplus of educated inhabitants with no jobs in which they can apply their training satisfactorily does not lead to national contentment

III. TYPES OF ESTATES

Two types of Estates are proposed: firstly, those in which commercial production is subordinated, at first, at least, to the provision of ample facilities for research and investigation, and secondly, those on which commercial production is the main aim and research only contributory to this.

It is not proposed to discuss the second type of estate in this paper. Such estates would at present be confined to crops the agronomy of which under similar conditions as obtain in the Gold Coast is adequately known. Such crops might include oil palm, ~~Hevea~~ rubber, robusta coffee, etc. Their success would depend, in the first place, on securing from abroad the services of experienced, practical agriculturalists already familiar with the crops proposed to be grown and in the second place, upon training local managers, technicians, overseers, accountants, etc. to carry on the work when the estates were established as going concerns.

The first type of estate, that having as its main function the provision of facilities for experimentation, is considered from the point of view of the development of the country to be initially more important. After their main investigatory work was completed, however, they would, in the majority of cases, assume the status of commercial estates on which research would be conducted solely as an aid to more efficient production instead of being devoted to determining the general methods by which particular types of agriculture should be carried on, or specific crops grown, under the environmental conditions prevailing locally.

The following Investigatory Estates are proposed :-

- A. Estates of about 2,500 acres devoted wholly or mainly to plant husbandry.

Two thousand five hundred acres, roughly 4 square miles, has been chosen as the size of these estates for a variety of reasons. Firstly, from personal experience I know that cultivated land of this extent can be controlled by one experienced cultivation manager; secondly, this size permits production on a sufficient scale to justify the employment of proper supervisory

staff and allows reliable production costs to be worked out; and, thirdly, it will provide adequate expances of uniform soils for field experimentation.

1. One or more cocoa estates employing salaried and daily-paid workers.
2. One or more cocoa estates run by peasant co-operative methods when the trees are established and bearing.

Both the above estates would be established on bush-covered land rather than on land covered by undisturbed forest and would have as one of their principal objects the working-out of a system of cocoa production with the use of artifical fertilizers.

- 3-6. Food Production Estates based on the maintenance of fertility using artifical fertilizers. Two of these, one in the forest zone and one in the savannah zone would be run on purely estate lines employing paid labour, etc. The remaining two, again one each in the forest and savannah zones, would, when they had been suitably laid out and established, be run as peasant co-operatives.

- 7-10. Food Production Estates based on the maintenance of fertility using vegetative fallows. It is considered that for an indefinitely long time it will be impossible, for a number of reasons, for the whole of the cropland to have its fertility maintained by the use of artificials. It is considered, too, that methods of maintaining fertility will have to be worked out by the modification and improvement of native systems (i.e. by bush and grass fallows) and not by the introduction of alien systems evolved under quite different environmental conditions. Mixed farming combined with crop rotation is excellent where one has industrial wastes and artificial fertilizers available and can import concentrated feeding stuffs but otherwise it cannot achieve much: cattle are not capable of manufacturing plant nutrients! Little or nothing can be hoped for from crop rotation alone.

It is suggested that there should be four of these Food Production Estates using vegetative fallows to maintain fertility, one in the forest and the other three in different parts of the savannah zone. Half of each of these estates would, after laying out and establishment, be run as peasant co-operatives and the remaining halves operated by paid employees principally for experimental purposes.

The principles by which these vegetative fallow estates would be worked will be discussed later in this paper.

It is proposed that the Food Production Estates, both those with fertility maintained by artificial fertilizers and those with fertility maintained by the use of vegetative fallows, be associated with experimental plants, properly staffed, for studying the processing, or partial processing, of the commodities produced. This work would be a development of the processing already carried on on a peasant scale, e.g. the preparation of garri, starch, corn meal, etc. This method of initiating industrialization would appear to have been overlooked by Professor Lewis (2).

The production of processed foods is a matter of outstanding importance: the fufu stick has no place in urban and industrial communities and increasing quantities of imported prepared foods are already being consumed.

B. Estates of about 640 acres devoted wholly or largely to irrigation agriculture.

10-12. Irrigation Estates. Two, one on the Accra Plains and one in the Northern Territories. These will be run wholly by estate methods.

13-14. Co-operative Irrigation Estates. Two, one on the Accra Plains and one in the Northern Territories. These will be on soils of medium to light texture easy for peasant farmers to handle.

C. Estates of about 10,000 acres devoted to stock rearing.

Ten thousand acres, about 16 square miles, are suggested for cattle ranches. On the basis of one animal unit per 10 acres of rough grazing the area suggested should support eventually 1,000 head.

/ Cattle ...

15-16. Cattle Ranches. Two fair-sized cattle ranches are suggested: one on the Accra Plains and the other in the Northern Territories. On each about 500 acres would be devoted to dry season irrigated fodder production. For beef production Zebu - (English) Shorthorn crosses are suggested. When the undertaking can be considered running satisfactorily and problems of dry season fodder production are overcome a certain amount of dairying should be undertaken using either Zebu-Dairy Shorthorn crosses or Zebu-Friesian crosses.

D. Estates of 320 acres (half a square mile) devoted to mixed Farming.

17-18. Mixed-Farming Estates. Two are suggested, one in the north of the Northern Territories and one in the central coastal plain area. Subject to satisfactory tsetse control they would be divided up as follows:

Permanent cropland	100 acres
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Rotation cropland with bush fallow	100 acres
(30 acres under crops; 70 acres under bush fallow)	

Improved grass	20 acres
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Rough grazing	100 acres
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It would carry about two dozen head of stock consisting of working oxen and dual purpose, beef and milk, animals.

Some mechanized tillage would also be required and a certain amount of artificial manuring.

The Order of Development of Investigatory Estates.

The order in which it is considered estates should be laid out is roughly that in which they have been dealt with above.

Responsibility for the working of Investigatory Estates.

It is suggested that the responsibility for the working of Investigatory Estates should devolve upon the Gold Coast Agricultural and Fisheries Development Corporation. This should run them on business lines as

/ profitably ...

profitably as possible in order to provide facilities for agronomic and other investigations. Their investigatory purpose however, is to be regarded as dominant and such returns as they may make would be offset against both capital and maintenance costs and the costs of investigation. Investigations would be under the control of the Department of Agricultural Research (see later), or in the case of costings, the joint responsibility of that Department and of the Corporation.

Whilst run as Investigatory Estates these undertakings would not have commercial profit as their main aim but research. As already indicated they might later develop into mainly commercial undertakings.

IV. SYSTEMATIZED VEGETATIVE FALLOWS AS THE BASIS FOR THE INTEGRATION OF PEASANT FARMING.

It has already been stated that it is only suggested that a small proportion of agricultural production should be by estate methods and that the remainder will have to be carried on by integrated peasant farming if the standards of living desired are to be attained. It has, too, already been indicated that it is quite unlikely that it will be possible to maintain soil fertility by the use of fertilizers except over a fraction of the country, chiefly in urban and industrial areas; and because of tsetse fly and other reasons, that mixed husbandry can never be expected to be effective except over limited expanses. This means that over by far the greater part of the country soil fertility will have to be maintained by means of vegetative fallows. It is for this reason that such prominence has been accorded Investigatory Estates with vegetative fallows.

The maintenance of soil fertility by means of vegetative fallows is the predominate type of tropical subsistence farming and it is considered that improvement in local food production will very largely have to be achieved by the development of this form of land-use. The recognized principles governing this type of farming are set out below.

1. Cultivation should be kept to a minimum.
2. The ground should be kept shaded; this involving the growth of low ground crops where other, tall, widely-spaced crops are cultivated.
(Both these procedures aim at conserving the soil organic matter, the main source of plant nutrients in the majority of tropical soils, from destruction by aeration and insolation).
3. Mixed cropping including at least one leguminous crop.
(Mixed cropping protects the soil as indicated above and serves purposes in some degree similar to crop rotation in mid-latitudes.)
4. Crop succession should be practised: a mixture of crops commencing with annuals giving place to one comprising semi-perennials that lead back to bush or bush and grass.
5. The growth of bush or grass for varying periods in order to rid the land of the weeds and other pests of cultivation, to re-constitute soil structure and to accumulate nutrients for a further period of cropping.
6. The carrying out of such procedures along the contour where relief, etc., renders this desirable in order to control soil erosion.

Bush fallowing is sometimes criticized on the grounds that it is far more extravagant in the use of land than is mixed farming, crop rotation, etc. A careful analysis of such statements shows them to have no justification: all plant nutrients come from the soil or air and the other farming systems are only more economical of land where manures or feeding stuffs are brought in from elsewhere.

One of the main disadvantages of bush fallowing is the labour involved in annual clearing. Bush cutting could be done mechanically. If necessary, easily-cut bush could be suitably planted for the purposes of renovation fallows. Agricultural mechanization could with advantage be mainly confined to this sort of work instead

of assuming that the tractor should be employed for the same purposes as in the eastern counties of England. Proper bush fallows leave the ground in excellent tilth free from weeds and no cultivation is needed thereafter that cannot be performed with a cutlass or hoe.

Research into the system of agriculture characterized by the principles set out above would consist of enquiries into the shrubs most efficient at maintaining fertility, having in mind the ease with which they can be dealt with by mechanical cutters, the most effective combinations of crops to be grown and the succession in which they can most profitably be produced, and numerous other matters. Some of these matters have already been proposed for investigation by leading agricultural experts, but nowhere carried out as far as I know.

Bush is a far better soil renovator than grass, especially planted grass. Experience in Sierra Leone (5), for example, demonstrates this. Much of the farming area of the Gold Coast reverts to grass or to sparse bush in which grass predominates. My observations suggest that bush fallows could be successfully employed in these regions were fire excluded.

The greater efficacy of dicotyledonous bush compared to monocotyledonous grass as a soil renovator can be understood by a study of their respective ash contents. Not only is the percentage ash of bush higher than that of grass but the former has significantly higher proportions of the divalent bases, calcium and magnesium and also phosphorus.

The adoption of proven shrubs as soil renovators will necessitate planting and possibly alignment to allow ease of mechanical cutting. The planting of specific bushes for fallow purposes is not unknown in West Africa, e.g. Acioa barteri and Macrolobium macrophyllum in Eastern Nigeria. The planting of crops and trees, etc., has always, in native African custom, been held to accord the planter recognized use of the land and has largely formed the basis of the increasing amount of individual ownership. The instance from Buganda, quoted during the last Summer Conference on African Administration, is an example of this (6)(7). It is suggested that the use of specially-planted fallows can be made to result in the stabilization of peasant subsistence agriculture and to promote its integration.

The economic value of bush fallows as suppliers of fuel for domestic purposes in both rural and urban areas must not be lost sight of. The need for such fuel, in rural areas at least, will continue even after the development of hydro-electric power. It is proposed that investigations should be made into other uses of bush fallows aside apart from their use as soil renovators. One such investigation would be into the possibility of growing species from which jute substitutes could be manufactured.

V. THE INTEGRATION OF PEASANT AGRICULTURE WITH SPECIAL REFERENCE TO TERRITORIAL ASPECTS

If any agricultural progress is to be made in the Gold Coast its peasant agriculture must be changed from its present chaotic condition, organized and integrated. Gold Coast people have to choose between the traditional, haphazard crop production and the political, economic and social benefits to which they aspire: they cannot enjoy both as many are beginning to realize.

As soon as one tackles the question of integration of peasant farming one comes up against the problems of tradition and custom as regards land tenure. It must not be imagined that in the suggestions shortly to be made that these have been overlooked: they have not. The position has been assumed as stated by Rowling (8) that "... generally speaking, the type of agriculture decides tenure, not tenure the crops and agricultural techniques". Type of agriculture in this maxim has been taken to include agricultural organization. Unless one adopts this attitude one can get nowhere. To attempt to fit modern agriculture into traditional customs is impossible. To the technical worker it often seems that the efforts of others have been directed in this connection more to the preservation of anthropological fossils than to the development of a modern tropical agricultural economy. It does not seem to be realized that custom and tradition are daily being outraged as the normal course of events. The verb 'to evolve' is too frequently accorded such a timid connotation that no progress is perceptible or even possible.

The organization proposed does not introduce anything that is particularly alien apart from organization itself. Since, as already pointed out, the major part of Gold Coast agriculture will have to depend upon vegetative fallows for the maintenance of soil fertility and since the agricultural system proposed is a systemization of vegetative fallowing, organization and integration is based on this.

At present in the forest country a family will have about three food farms in operation in any one growing season: a farm cleared from bush in the current year, a farm cleared the year before and another cleared the year before that. These farms are normally scattered and it may be argued that this acts as an insurance against adverse weather affecting one piece of land more than another or of pests and diseases behaving similarly. More likely this is merely the result of a haphazard system of land tenure. It is suggested that all farms be adjacent. It is also suggested that the farmer considers the bush fallow as part and parcel of his land. This may be the case now; the word 'may' in the first part of this sentence is intentionally underlined. If, however, he plants and aligns a particular shrub or mixture of shrubs as a bush fallow, the farmer will undoubtedly regard land so planted as his own.

The result of the changes suggested, if effectively organized, would be that the farmer owned and worked a strip of land some of which was under crops and the rest under bush. With an average family of five persons planting four acres a year and with a bush fallow of seven years duration this would be achieved with a strip 2 chains wide and 40 chains long (= 40 acres). Of this area 12 acres would be under cultivation (3rd, 2nd and 1st years) and 28 acres under bush varying from one to seven years in age. In this strip four acres would be cleared and planted annually in order from one end to the other and after three years' cropping, or partial cropping, be allowed to revert to selected bush.

These strips it is proposed should be aligned as far as possible at right angles to the relief so that bottom as well as upland is included. This could allow for dry season vegetables, etc., and wet season rice to be grown in the bottoms and food stuffs and perennials on the well drained uplands.

It is for the purpose of improving the agriculture on these bush fallowed strips that the Investigatory Food Production Estates using vegetation fallows have been devised.

The suggested size and dimensions of the strips and the amount of land to be cleared and planted annually are merely tentative. It is probable, in the forest region at least, that the 12 acres under first, second and third year crops would yield a large surplus of food stuffs, and that part of the strip could be permanently in perennials such as cocoa, coffee, etc.

The layout and alignment of such strips in savannah country might have to be altered in order to control soil erosion. This would certainly be so were a grass fallow to be employed to maintain fertility, thus necessitating ploughing for efficient clearing, but it might not be so were a satisfactory bush fallow to be evolved following which ploughing would not be needed.

Integration

Agricultural development cannot make any consistent progress unless it is known where particular crops are grown and how much of each are produced. Such distributional information is also essential for the efficient control of pests and diseases as was discovered in the case of virus disease of cocoa. To obtain the necessary statistical data and also to permit of thorough extension work and the control of pests and diseases an areally-integrated organization is required.

It is suggested that the smallest unit of integration consisting of farmers' strips should be about 9 square miles in size; that these should be combined into rural districts of about 90 square miles, these into counties of about 900 square miles, these into provinces of about 9,000 square miles and these into the four major administrative areas already existing. The above suggestions are meant to be merely tentative: agricultural groupings for statistical and other purposes should of course coincide with administrative regions. The satisfactory administrative subdivision of the Gold Coast has still to be worked out. It should be borne

in mind, however, in devising such that the Gold Coast is, and presumably always will be mainly agricultural, and land-use will have to be taken into account if administrative subdivisions are to have any real significance and value.

Each of these agricultural administrative groupings of varying category should be in charge of an agricultural officer, or officers, of suitable status responsible for the collection of statistics regarding acreages planted to particular crops and yields, for extension work and for disease and pest control, etc.

This would mean an areal agricultural organization far exceeding that existing at present, but not one that the Gold Coast could not afford.

It is unnecessary to state the integration outlined above could not take place over-night. It is not suggested, either, that it should be in any way forced on an unwilling population. It is hoped that the provision of cultivation aids, such as mechanized bush cutting, etc., will encourage the orderly consolidation of farms and their integration into groups of the lowest category suitable in size for the activities of a tractor-unit.

The layout of model village units along the lines suggested on lands acquired by Government for the purpose at an early stage is most desirable. These would be considered as investigatory areas, not as estates, with the object of determining the principles of fitting strips into varieties of the most prevalent forms of landscape.

Such investigatory areas would be run by the Department of Agricultural Administration and the investigatory work carried out on them by this Department in conjunction with the Department of Agricultural Research, cf. later. Subsequent design and layout of such units throughout the remainder of the country would be extension work of the former organization.

VI. THE ORGANIZATION OF AGRICULTURAL RESEARCH AND AGRICULTURAL ADMINISTRATION

It will be noted from what has been stated so far that considerable increases in the staffs engaged in research and extension are deemed necessary. Since the total staffs of each section would be of some magnitude and since the work of each section, although concerned with the same industry, is quite different in character - requiring different types of administrative supervision, it is maintained that their activities should be the responsibility of separate departments: a Department of Agricultural Research and a Department of Agricultural Administration. There is a precedent for this in the Belgian Congo where research is carried out by the Institut National pour l'Etude Agronomique du Congo Belge and the administration of agriculture by the Service d'Agriculture. The respect which is accorded the Belgian work is sufficient evidence that this procedure is an efficient one.

An additional comment or two on research being conducted by a separate department may be given. Research into tropical agriculture needs emphasis and this will be provided by making it the responsibility of a separate department. To the majority of the problems of tropical agriculture we have no answers. It is because of this that in the last few years the tropics have been largely rejected as providing the best opportunity for augmenting the world's food supplies and temperate lands, considered instead (9). Whilst the appearance of much research being carried out has been given, very little indeed has really been achieved. One of the main reasons for this has undoubtedly been the almost complete absence of any real administration and direction of the research effort. It has suffered from fragmentation and incoherence - the same maladies as affect tropical peasant agriculture itself.

In most colonial departments of agriculture research has been conducted by a mere handful of specialists frequently with no reliefs so that there has been much discontinuity of work. Quite usually

/ such ...

such specialists are technically undirected and unprovided with guidance or with adequate equipment and library services. Where direction has been given it is by no means unknown for the person responsible to have had no research experience himself. Further, there has been much local tinkering with identical problems in many parts of the tropics by workers quite oblivious of what others are doing or have already done, instead of a concerted attack on fundamental questions affecting all tropical territories. The natural consequence is our present ignorance and the many costly agricultural development schemes that have failed in the post-war years.

Another serious shortcoming has been 'colonialism' in research: the concentration of investigations into the production of commodities for export instead of organized studies into efficient land-use designed to provide the inhabitants of particular areas with food, clothing, etc. This has already been the subject of outside criticism (10). Experimental stations perhaps were in some cases intended to carry out such work but they are in the vast majority of cases wholly inadequate for such purposes.

What is required is for research not only to be greatly amplified but to be under experienced direction and, of course, provided with adequate means in the way of equipment, particularly library facilities. Unless this is done competent workers will never be obtainable in sufficient numbers. In a small or moderate size territory all this is facilitated by combination of research workers in related spheres into one organization. Thus, as in the case of the Institut National pour l'Etude Agronomique du Congo Belge (and the East African Regional Research Organization) a department of agricultural research would comprise the specialists in soils, agronomy, animal husbandry and forestry. This would not only effect economies where direction and facilities were concerned but would result in profitable co-ordination of work. In the Gold Coast, for example, despite the fact that the forest and secondary bush play highly

important rôles in crop production neither the Departments of Agriculture nor Forestry have ever studied them from this point of view. Vast areas of the country are covered by different grass associations affecting both plant and animal husbandry yet again these have been nobody's business.

To carry out the necessary research on the Investigatory Estates described earlier a staff of specialists, additional to those already on the establishment, of not less than sixty would be required. This may appear at first an inordinately large number, when, however, this number is compared with that engaged on similar work in a State such as Alabama, for example, it will be appreciated that it is not. Alabama has been instanced as the standard of living that the Gold Coast people are aiming at is comparable with that of the inhabitants of such a State.

Obtaining such a large number of specialists would be a problem but not necessarily an impossible one: recruitment need not be confined to the United Kingdom and collection of staff would need to be gradual, i.e. extending over the Second 5-Year Plan.

VII. CONCLUSION

At first perusal the proposals outlined in this paper may appear unrealistic. Careful consideration of what has been stated in the Introduction, however, should convince anyone that they are not, but that suggestions of lesser magnitude would be. Proposals of the sort made are essential if agriculture in the future is to support the political and social structure that the people of the Gold Coast consider their natural right.

The first part of the report deals with the general situation of the country and the progress of the work during the year. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the plans for the future.

The second part of the report contains a list of the various projects and the results achieved. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the plans for the future.

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The ninth part of the report contains a list of the various projects and the results achieved. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the plans for the future.

The tenth part of the report contains a list of the various projects and the results achieved. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the plans for the future.

REFERENCES

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9. Stamp, Dudley L., 1953 Our Undeveloped World. Faber and Faber, London.
10. Kellog, Charles E. and Daval Fidelia D., 1949 An exploratory study of soil groups in the Belgian Congo. Serie Scientifique No. 46. Institut National pour l'Etude Agronomique du Congo Belge.

RECEIVED AT THE OFFICE OF THE SECRETARY OF THE ARMY
WASHINGTON, D. C. JANUARY 10, 1900

TO THE SECRETARY OF THE ARMY
FROM THE SECRETARY OF THE ARMY
SUBJECT: [Illegible]

[Illegible text block containing several paragraphs of a memorandum or letter]

[Illegible text block containing several paragraphs of a memorandum or letter]

[Illegible signature or stamp]

Office Memorandum • UNITED STATES GOVERNMENT

TO : Charles E. Kellogg, Assistant Administrator for DATE: November 21, 1955
Soil Survey, SCS

FROM : Lyle T. Alexander, Chief, Soil Survey Laboratory,
Beltsville, Maryland

SUBJECT: Composition - Akuse Series - Gold Coast Soil

Lyle T. Alexander
L.B.

We are returning herewith your correspondence and profile description of the profile of soil from the Gold Coast that you gave to us for analysis. The data are given on the enclosed tables. We would be glad to discuss with you any matter pertaining to the interpretation of the data that you may wish.

Attachments

*Appendix,
Hansen Journal*

IN CASE OF REPLY THE
NUMBER AND DATE OF THIS
LETTER SHOULD BE QUOTED

Telegrams: Chiefsoil Kumasi
Telephone: Kumasi 653



Department of Soil and Land-Use Survey,

Private Mail Bag,

Kumasi, Gold Coast Colony.

Ref. No. ST.3/10/19

4 January, 1955.

Dear Dr. Kellogg,

Thank you for your letter of December 22nd and for the advice it contained. I have been on the 'phone to Mead and he assures me that the F.O.A. representative not only understood that I would be working with the soil survey of the Soil Conservation Service and that you would be responsible for arranging my programme but welcomed this. If you would care to check up on arrangements in Washington it was a Mr. W.E. Moran with whom Mead made the initial arrangements before referring the matter to the Colonial Office in London. I, myself, had nothing to do with it other than signing on the dotted line: my original plan was to come at my own expense if Government would release the necessary amount of U.S. currency. Anyhow, I will keep you informed of further developments.

"When I come to the States I would like to bring duplicates of my grass collection with me for authoritative determination. There would be about 200 species the great majority of which we have already run down but our determinations could do with checking. You might think this could be done at Kew but unfortunately C.E. Hubbard who is in charge of grasses has only one young assistant and identifications can only be expected in the somewhat remote future. I am not aware who has replaced Hitchcock and Chase since the former died and Mrs. Chase retired and would be very grateful if you would inquire whether their successors would be agreeable to undertake this job and if so what arrangements would be needed to get the collection through customs and quarantine."

When you visited the Accra plains with Brammer you asked to have profile samples of one of the Black Earths you inspected forwarded to you. These were despatched from here on November 23 and shipped from Takoradi on December 21st by m/v Accra for Liverpool where they will be transhipped to the States. Enclosed are the profile description and such analytical data as are available - the profile you wished sent was not one of those we analysed in full. Reactions were determined by the glass electrode in a 1:1 soil-water paste; gross mechanical analysis was by sieving and mechanical analysis of the fine earth by the beaker sedimentation method, the results being calculated on an oven-dry basis; organic carbon was determined by a modified Walkley-Black method and total nitrogen by the standard Kjeldahl procedure.

DR. CHARLES E. KELLOGG,
ASSISTANT ADMINISTRATOR FOR SOIL SURVEY,
SOIL CONSERVATION SERVICE,
UNITED STATES DEPT. OF AGRICULTURE,
WASHINGTON 25, D.C.
U.S.A.

Department of Soil and Land-Use Survey,
Private Mail Bag,
Kumasi, Gold Coast Colony.



REPLY TO THIS
NUMBER AND DATE OF THIS
LETTER SHOULD BE QUOTED

Postmaster: Kumasi 653
Kumasi, Gold Coast Colony

No. ST. 3/10/19

1955. January.

Dear Dr. Kellogg,

Thank you for your letter of December 22nd and for the advice it contained. I have been on the 'phone to Mead and he assures me that the F.O.A. representative not only understood that I would be working with the soil survey of the Soil Conservation Service and that you would be responsible for arranging my programme but welcomed this. If you would care to check up on arrangements in Washington it was a Mr. W.E. Moran with whom Mead made the initial arrangements before referring the matter to the Colonial Office in London. I, myself, had nothing to do with it other than signing on the dotted line: my original plan was to come at my own expense if Government would release the necessary amount of U.S. currency. Anyhow, I will keep you informed of further developments.

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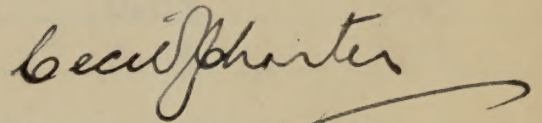
When you visited the Accra plains with Brammer you asked to have profile samples of one of the Black Earths you inspected forwarded to you. These were despatched from here on November 25 and shipped from Takoradi on December 21st by m/v Accra for Liverpool where they will be transhipped to the States. Enclosed are the profile description and such analytical data as are available - the profile you wished sent was not one of those we analysed in full. Sections were determined by the glass electrode in a 1:1 soil-water paste; gross mechanical analysis was by sieving and mechanical analysis of the fine earth by the beaker sedimentation method, the results being calculated on an oven-dry basis; organic carbon was determined by a modified Walkley-Black method and total nitrogen by the standard Kjeldahl procedure.

DR. CHARLES E. KELLOGG,
ASSISTANT ADMINISTRATOR FOR SOIL SURVEY,
SOIL CONSERVATION SERVICE,
UNITED STATES DEPT. OF AGRICULTURE,
WASHINGTON 25, D.C.
U.S.A.

"I have been attempting through the Crown Agents' representative at Washington to find out whether the Veihmeyer sampling tube is manufactured in the States for sale and if so by whom but so far have not received any definite information. If USDA uses this implement for securing soil samples for moisture determinations on irrigated lands I would be most grateful if you could let me know who manufactures it; alternatively, if you use some other piece of equipment for this purpose could you send me particulars and tell me where it can be obtained."

With my kind regards and best wishes.

Yours sincerely,



DIRECTOR,
SOIL & LAND-USE SURVEYS.

sba.

I have been attempting through the Crown Agents' representative at Washington to find out whether the Volkswagen sampling tube is manufactured in the States for sale and if so by whom and so far have not received any definite information. If USDA uses this implement for securing soil samples for moisture determinations on irrigated lands I would be most grateful if you could let me know who manufactures it; alternatively, if you use some other piece of equipment for this purpose could you send me particulars and tell me where it can be obtained.

With my kind regards and best wishes.

Yours sincerely,



DIRECTOR,
SOIL & LAND-USE SURVEYS.

Available Analytical data for Profile No. APA 439. Akuse Series.

Lab. No. A. 128.

Survey: Accra Plains

<u>Lower depth of</u> <u>horizon in inches:</u>	<u>Reaction</u>		<u>Organic Matter %</u>	
	<u>pH</u>	<u>CaCO₃%</u>	<u>Carbon.</u>	<u>O. M.</u>
0 - 7	6.7	0.02	1.27	2.18
- 18	7.3	0.02	0.63	1.08
- 42	7.6	0.23	0.54	0.93
- 54	8.0	23.40	0.18	0.31
- 64	8.0	0.13	0.03	0.05
- 84	8.0	0.02	0.03	0.05

			<u>Coarse Material. %.</u>		<u>Fine Earth %.</u>	
		<u>>20mm.</u>	<u>20-6.25mm.</u>	<u>6.25-2.0mm.</u>	<u><2mm.</u>	
0	-	7	nil	0.1	0.8	99.1
	-	18	nil	5.2	0.7	94.1
	-	42	3.7	4.2	0.8	91.3
	-	54	nil	11.7	0.3	88.0
	-	64	nil	nil	nil	100.0
	-	84	nil	nil	nil	100.0

SERIES

AKUSE

NO :-

APA 439/1-6

LOCALITY :- Approx, 2ch. West of M.P.30 Accra-Ada road.
 SITE :- Middle Slope of Gentle Undulation.
 VEGETATION :- Savannah.
 ALTITUDE :- Approx 110'.
 RAINFALL :- 25" +.
 SOURCE :- Profile Pit 3' x 5' x 7'.
 DATE COLLECTED:- 2nd April, 1952.

BAG NO.

PROFILE DESCRIPTION

55949

K 5189. 0 - 7"

Very dark grey brown clay, with abundant rootlets; occasional very fine iron-stained quartz gravel and coarse quartz sand, and rare ironstone concretions; nutty and compact. MnO_2 present. pH 6.7.

950

k 5004. 7 - 18"

Dark grey brown clay with rootlets; fine to very fine quartz gravel and occasional ironstone concretions. Cloddy and compact. MnO_2 present. pH 7.3.

951

K 5178. 18 - 42"

Dark grey clay with occasional fine quartz gravel, with few rootlets and rare concretions of calcium carbonate; Cloddy and compact. MnO_2 present pH 7.6.

952

K 5177. 42 - 54"

Very dark greyish brown clay, with fine quartz gravel and abundant calcium carbonate concretions and rare manganese concretions; cloddy and compact. pH 8.0.

953

K 5179. 54 - 64"

Dark grey brown clay slightly mottled orange and yellow, with abundant decomposed rock fragments and calcium carbonate concretions; MnO_2 present. structureless. pH 8.0.

954

K 5183. 64 - 84"

White and yellow decomposed rock, garnetiferous hornblende gneiss. pH.8.0.

LOCATION Gold Coast, Africa

SOIL SURVEY LABORATORY

SOIL TYPE Akuse ClayBeltsville, MarylandFIELD
-SAMPLE NO. K5189, K5004, K5178, K5177,
K5179, K5183

LABORATORY NUMBER	DEPTH IN INCHES	HORIZON	PARTICLE SIZE DISTRIBUTION (in mm.) (per cent)										TEXTURAL CLASS		
			VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	0.02- 0.002 0.2-0.02 0.02-0.002 <0.005	> 2				
55949	0-7		1.0	3.4	4.1	8.5	6.0	23.5	53.5	17.5	16.9	0	clay		
55950	7-18		2.2	4.6	4.5	10.3	7.4	23.2	47.8	21.7	14.8	0	clay		
55951	18-42		1.7	4.5	4.1	8.7	7.5	22.8	50.7	20.5	15.0	0	clay		
55952	42-54		17.7	9.7	3.8	6.3	5.2	22.8	34.5	16.3	15.4	15	clay loam		
55953	54-64		10.6	8.2	5.9	15.0	12.6	17.7	30.0	30.1	9.4	18	sandy cl.l.		
55954	64-84		18.3	14.8	9.8	20.6	12.8	13.3	10.4	32.2	5.7	15	sandy loam		
		pH	ORGANIC MATTER			EST. % SALT (BUREAU CUP)	ELECTRICAL CONDUCT- IVITY EC x 10 ³ MILLIMHOS PER CM @ 25°C	CaCO ₃ equivalent per cent	Fe ₂ O ₃ GYPSUM me/100g SOIL	MOISTURE TENSIONS					
		SATURATED PASTE 1:1	1:5	1:10	% ORGANIC CARBON	% NITROGEN	C/N			1/10 ATMOS.	(per cent) 1/3 ATMOS.	15 ATMOS.			
55949	6.5				1.47	0.11	13.4			1.7	1.1				
55950	7.0				0.70	0.05	14.0			1.9	1.2				
55951	7.4				0.55	0.04	13.8			2.8	1.2				
55952	7.9				0.15	0.05	3.0			33.2	0.7				
55953	7.8				0.06	0.01	6.0			2.1	1.3				
55954	8.0				0.01	0.007	1.4			1.5	1.3				
		CATION EXCHANGE CAPACITY	EXCHANGEABLE CATIONS				H EXCHANGE- ABLE SODIUM PERCENTAGE ESP	% Base satura- tion	SATURATION EXTRACT SOLUBLE					PER CENT MOISTURE AT SATURATION	
			Ca	Mg	Na	K		K	CO ₃	HCO ₃	Cl	SO ₄			
			milliequivalents per 100g soil						milliequivalents per liter						
55949	50.6	26.2	19.6	1.3	0.3	3.2	94								
55950	47.5	29.4	13.7	2.6	0.1	1.7	96								
55951	51.1	31.0	15.0	4.6	0.1	0.4	99								
55952	53.4	37.5	11.5	4.3	0.1	<0.1	100								
55953	33.9	19.6	10.4	3.8	0.1	<0.1	100								
55954	17.1	10.0	5.2	1.9	<0.1	<0.1	100								

AGR-SCS-BELTSVILLE, MD. 2682 JUNE 195

Lab. No.	Mi	Vm	Kl	Gb	Gt	Qt	Hm
55949		xxxx	17			x	
55950		xxxx	20			x	
55951	x	xxxx	16			x	
55953		xxxx	Tr			x	
55954		xxxx				x	

Mi = mica; Vm = vermiculite; Kl = kaolin; Gb = gibbsite; Gt = goethite;
Qt = quartz; Fl = feldspar; Hm = hematite.

Relative concentrations: x = detected; xx = moderate; xxx = abundant;
xxxx = dominant.

LOCATION Gold Coast, Africa

SOIL SURVEY LABORATORY

SOIL TYPE Akuse ClayBeltsville, Maryland

FIELD

SAMPLE NO.

S. K5189, K5004, K5178, K5177,
K5179, K5183

LABORATORY NUMBER	DEPTH IN INCHES	HORIZON	PARTICLE SIZE DISTRIBUTION (in mm.) (per cent)										TEXTURAL CLASS	
			VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	0.02-0.002 0.02-0.002	0.02-0.002 <0.005	> 2		
55949	0-7		1.0	3.4	4.1	8.5	6.0	23.5	53.5	17.5	16.9	0	clay	
55950	7-18		2.2	4.6	4.5	10.3	7.4	23.2	47.8	21.7	14.8	0	clay	
55951	18-42		1.7	4.5	4.1	8.7	7.5	22.8	50.7	20.5	15.0	0	clay	
55952	42-54		17.7	9.7	3.8	6.3	5.2	22.8	34.5	16.3	15.4	15	clay loam	
55953	54-64		10.6	8.2	5.9	15.0	12.6	17.7	30.0	30.1	9.4	18	sandy cl.	
55954	64-84		18.3	14.8	9.8	20.6	12.8	13.3	10.4	32.2	5.7	15	sandy loam	
	pH		ORGANIC MATTER			EST. % SALT (BUREAU CUP)	ELECTRICAL CONDUCTIVITY EC x 10 ³ MILLIMHOS PER CM @ 25°C	CaCO ₃ equivalent per cent	Fe ₂ O ₃ GYPSUM me./100g SOIL	MOISTURE TENSIONS				
	SATURATED PASTE 1:1	1:5	1:10	% ORGANIC CARBON	% NITROGEN					1/10 ATMOS.	(per cent) 1/3 ATMOS.	15 ATMOS.		
55949	6.5			1.47	0.11	13.4			1.7	1.1				
55950	7.0			0.70	0.05	14.0			1.9	1.2				
55951	7.4			0.55	0.04	13.8			2.8	1.2				
55952	7.9			0.15	0.05	3.0			33.2	0.7				
55953	7.8			0.06	0.01	6.0			2.1	1.3				
55954	8.0			0.01	0.007	1.4			1.5	1.3				
	CATION EXCHANGE CAPACITY	EXCHANGEABLE CATIONS				H EXCHANGEABLE SODIUM PERCENTAGE ESP	Na saturation Clon	SATURATION EXTRACT SOLUBLE					PER CENT MOISTURE AT SATURATION	
		Ca	Mg	Na	K			K	CO ₃	HCO ₃	Cl	SO ₄		
		milliequivalents per 100g soil							milliequivalents per liter					
55949	50.6	26.2	19.6	1.3	0.3	3.2	94							
55950	47.5	29.4	13.7	2.6	0.1	1.7	96							
55951	51.1	31.0	15.0	4.6	0.1	0.4	99							
55952	53.4	37.5	11.5	4.3	0.1	0.1	100							
55953	33.9	19.6	10.4	3.8	0.1	0.1	100							
55954	17.1	10.0	5.2	1.9	0.1	0.1	100							

SOIL SURVEY LABORATORY

Baltimore, Maryland

SOIL TYPE

UNKNOWN CLAY

LOCATION GOLD GORGE, ALABAMA

SAMPLE NO.

FIELD NO. 1000, 1001, 1002, 1003, 1004

LABORATORY NUMBER	DEPTH IN INCHES	HORIZON	PARTICLE SIZE DISTRIBUTION (in mm.) (per cent)							TEXTURAL CLASS			
			VERY COARSE SAND	COARSE SAND	MEDIUM SAND	FINE SAND	VERY FINE SAND	SILT	CLAY				
			2-1	1-0.5	0.5-0.25	0.25-0.10	0.10-0.05	0.05-0.005	0.005-0.002	<0.002			
55949	0-7		1.0	3.4	4.1	8.5	6.0	22.5	17.5	15.9			
55950	7-18		2.8	4.6	4.5	10.3	7.4	24.2	17.8	14.8			
55951	18-45		1.7	4.5	4.1	8.7	7.5	22.4	20.7	15.0			
55952	45-64		17.7	9.7	5.8	6.3	5.2	24.8	34.5	19.4			
55953	64-84		10.6	8.5	5.9	12.0	15.6	17.7	30.0	24.1			
55954	84-84		18.3	14.8	9.8	20.6	18.8	13.5	18.4	32.5			
			pH			ORGANIC MATTER			MOISTURE TENSIONS				
			SATURATED PASTE 1:1	1:2	1:10	CARBON	NITROGEN	EST. % SALT (BUREAU CUP)	ELECTRICAL CONDUCTIVITY EC x 10 ³ MILLIMOS PER CM @ 25°C	CaCO ₃ equivalent per cent	GYPSUM SOIL		
											1:10	1:3	
55949	6.5					1.47	0.11	13.4			1.1	15	
55950	7.0					0.70	0.07	14.0			1.3	ATMOS.	
55951	7.4					0.55	0.04	13.8			1.2	ATMOS.	
55952	7.9					0.15	0.07	3.0			0.7	ATMOS.	
55953	7.8					0.06	0.01	6.0			1.5	ATMOS.	
55954	8.0					0.01	0.007	1.4			1.3	ATMOS.	
			EXCHANGEABLE CATIONS			SATURATION EXTRACT SOLUBLE			PER CENT MOISTURE AT SATURATION				
			CAPACITY	EXCHANGE	CATION	Ca	Mg	Na	K	CO ₃	HCO ₃	Cl	20°
55949	20.6		26.2			19.4	1.3	0.3	3.2				
55950	47.5		29.4			13.7	2.6	0.1	1.7				
55951	51.1		31.0			15.0	4.6	0.1	0.4				
55952	53.4		37.5			11.5	4.3	0.1	0.1				
55953	33.9		19.6			10.4	3.8	0.1	0.1				
55954	17.1		10.0			5.3	1.9	0.1	0.1				

3

DEPARTMENT OF SOIL & LAND-USE SURVEY, GOLD COAST.

~~RESTRICTED~~

ESTATE AGRICULTURE AND THE
INTEGRATION OF PEASANT FARMING

by

C. F. Charter

May, 1954.

C. E. Kellogg Esq.

6

with compliments

UNIVERSITY COLLEGE OF THE GOLD COAST

7/8/54
Aug 7

GUIDE

TO THE

AGRICULTURAL

RESEARCH STATION,

NUNGUA

1954

FACULTY OF AGRICULTURE

S. SMUTS - Soil Conservation & Irrigation
F. KAGENZIEKER - SOIL CHEMIST.
R. F. LOXTON - SOIL & LAND USE
R. ROSE-INNES - Grassland Ecology.
E. PEACOCK - Research Fellow
Plant Protection { Entomology
Plant Pathology
P. R. HILL. Farm Manager

UNIVERSITY COLLEGE AGRICULTURAL RESEARCH STATION, NUNGUA.

THE CHALLENGE

There are over half a million acres of the gently undulating grassland known as the Accra Plains. This great area is used at present only for rearing poor quality cattle at the low density of about 12 acres per beast, and for producing a little cassava. The reasons for this low productivity lie in the erratic rainfall and unmanageable soils of the Plains, affecting crops, grass and settlement. Without any further consideration such an area presents a challenge to modern scientific agriculture. But there is the additional fact that if the Volta dam is built some of the water stored may be fed by gravity to the Plains and used to irrigate about 200,000 acres. Can this area, with or without irrigation, be used to provide food crops and livestock products for the growing population of the country? This is one of the questions which the new University College Faculty of Agriculture has set itself to answer, and it was for this purpose that the land for the Agricultural Research Station at Nungua was acquired a year ago.

More specifically, the agricultural problems which the Research Station is dealing with may be briefly stated as follows:—

Dry Land Farming

(a) Is it possible to grow food crops economically on the Plains? This may well prove impossible for such crops as cereals, but there are other possibilities—for example, there may be a place for the mechanised production and processing of cassava.

(b) Can fodder crops, such as green maize, millet, centrosema etc. be grown for livestock; and can the production and quality of the natural grassland be improved to support more and better animals?

(c) Can the quality of cattle, sheep or other animals be raised by improved breeding, better feeding and the control of disease?

Irrigation Farming

With adequate water supply, the growing of a host of crops such as rice, tobacco and sugar cane, becomes possible, but each raises its own problems. What, for example, are the most suitable methods of applying water to the land for each crop? How often, and how much? What are the most suitable varieties? Here are problems for the irrigation engineer, the agronomist, the plant breeder and the soil scientist. There are no precedents for this kind of work in West Africa. Full use is being made of experience in other parts of the world, but nowhere are conditions more than approximately the same. We start virtually from scratch.

THE SITE

The station at Nungua is well situated for research into these problems. It is in the south-west corner of the Accra Plains, 11 miles in a straight line from Accra, and 10 miles by road from the University College at Legon. It is approached by a road running eastward from the Accra-Dodowa road at mile 11, and this road leads to the Government Veterinary Station which adjoins the site. The Research Station consists of 1000 acres of grassland typical of the plains generally, and is bounded on its north side by the usually dry Mamahuna valley. The annual rainfall on the Station is 25 ins. while that on the Plains as a whole ranges from 25 to 42 ins. There is a range of soils typical of the main types found on the Plains as a whole. A dam has been constructed across the Mamahuna valley, and this will store sufficient water for livestock and domestic needs, and for irrigation experiments on about 80 acres of land. An aerial map of the Station and another of the catchment area has been made by the courtesy of Aerosurveys, Johannesburg. The map of the Station is on a scale of 1:5,000, and shows contours at 2½ ft. intervals.

Climate

A table showing the rainfall at Nungua Veterinary Farm for the past eight years is given on page 10. The rainfall is concentrated in two seasons. The major rains last from March to July and reach a peak in May and June; the minor rains extend from September to November with a lesser peak in October. Only during May and June does the average rainfall exceed 4 ins. per month, which is usually regarded as a working minimum for the active growth of annual crops, and in any month there are likely

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UNIVERSITY COLLEGE OF THE GOLD COAST, ACHIMOTA, WEST AFRICA.

FOR INTERNAL AND LIMITED PRIVATE CIRCULATION.

to be irregular dry spells. The atmosphere is humid and, except during storms, there is by day a steady sea breeze from the south-west. A meteorological station has been set up, and is equipped with a range of thermometers, a Piche evaporimeter, a standard 5 ins. and a tilting-siphon self-recording rain gauge, a sunshine recorder, a wind vane and anemometer, a thermo-hygrograph and a barometer. Other instruments are being added.

Vegetation

The grassland of the plains is burnt at least once a year to encourage fresh grazing. It is not known for certain what the vegetation has been in the past or what it would become now if protected from fire. The dominant grass is *Veteveria fulvibarbis*, which stands some 3 ft. to 4 ft. high. *Dichrostachys glomerata* is a troublesome spiny undershrub. The grassland is studded with large termite mounds (*Macrotermes* sp.), and the old mounds support the characteristic tree of the plains—*Elaeophorbia drupifera* and deciduous shrubs such as *Fluggia virosa* and *Grewia carpinifolia*. The mounds hamper clearing, and at present are being left to break down naturally except on irrigated areas.

Soils

A soil survey has recently been completed. On the simplified map which appears at the end three main groups are distinguished—the dark clays, the grey sands, and the valley soils.

(a) The clays are usually over 3 ft. deep and grade from black to dark brown in colour. In the dry season they shrink considerably, leaving the soil mass interlaced with a network of cracks. After rain they swell and eventually turn into a sticky mass. Drainage is poor. Timely tillage is essential, for, except over a limited range of moisture contents, the soil is either too dry or too sticky. These soils cover a considerable proportion of the Accra Plains, and have been distinguished by the Soil and Land-Use Survey Department as the Akuse series.

(b) The grey sands consist of a layer of medium or fine sand overlaying at depths from 6 ins. to about 2 ft. quartz gravel, rock, or a compact sandy clay pan. There is virtually no drainage through the soil, all excess water running off the surface. Once thoroughly wet, the topsoil takes a long time to dry and seriously delays tillage. When dried, the surface is inclined to pack, thus increasing the tendency for water to pour off the surface and cause erosion. The coarser sands have been called the Simpa series, and the finer, the Agataw series.

(c) The valley and drainage channel soils form a miscellaneous group ranging from sands to clays. They are not cultivated since under natural conditions they flood after heavy rain, and on the station they are used to carry excess water from the anti-erosion banks safely to the main valley.

Chemically, all these soils are neutral or slightly acid. They are seriously short of nitrogen, as is shown by the yellow colour of the grasses of the plains, and phosphorus. In a preliminary trial last year, 2 cwt. per acre each of sulphate of ammonia and superphosphate raised hay yields by 150 per cent and gave a large increase in later cuts.

Irrigation

Details of the dam which has been constructed will be found in the section on Soil Conservation and Irrigation. Pumping machinery and pipe lines are being installed, and preliminary experiments on irrigated crops are planned to start in September.

TEACHING

In addition to its function as a centre of research for the Accra Plains, the station helps to serve the teaching needs of the Agricultural Faculty by providing close at hand a place where students may become familiar with crops, livestock, irrigation methods and modern agricultural equipment, and also gain some idea of the scope of agricultural research by seeing it in action within a well defined framework. Naturally all their practical knowledge cannot be acquired at Nungua, for they must be familiar with agriculture in widely different regions—for example, the forest—but by familiarity with the methods of one station, such as Nungua, they learn the approach needed in attempting to improve the agriculture of any region.

The station also serves as a base for the Faculty's agricultural machinery, and as a proving ground for new machinery that needs testing under tropical conditions.

The programme of research and teaching is handled by the divisions of the Faculty. These are: Agricultural Engineering, Animal Health, Animal Production, Crop Production, Economics, Soil Conservation and Irrigation, and Soil Science and Agricultural Chemistry; the Faculty also receives the assistance of the University College's departments of Botany and Zoology for special problems. The day to day work of the station, and the costing of all operations, is the responsibility of the Farm Manager.

In the following pages a brief statement of the inten-

tions of each of these divisions is given, together with a more detailed explanation of such work as you may expect to see on the land in this first year.

AGRICULTURAL ENGINEERING

Policy

The activities of this division are three: teaching, research and testing.

The primary aim of the practical classes for agricultural degree students will be to inculcate a "machinery sense" by means of instruction and practice in the operation, maintenance and repair of tractors, vehicles, and the simpler machines and implements. Later there may be postgraduate or refresher courses on more complicated or newly-introduced equipment.

The experimental and research work will be directed towards solving problems of immediate importance in Gold Coast agriculture, particularly those presented by the Accra Plains. Priority will be given to the problems of clearing land for arable use; determining the optimum intensity and frequency of arable cultivations; the mechanized production and processing of cassava; and the mechanized harvesting of ground nuts. This work will involve both the systematic testing and modification of existing machines and the development of new ones.

In addition to work on machines bought or made for experimental purposes, it is proposed to institute a scheme whereby new machines or ones requiring further development are tested in co-operation with their manufacturers or other research organizations. The body whose machine is to be tested will probably also send a technical representative to supervise the test, and he will be accommodated at the station. The Research Station and the Agricultural Engineering division will provide crops, tractors and personnel for the test, and workshop facilities for modifying the machine as the test progresses.

Work in Progress this Year

Experimental work this year is limited by lack of a workshop and is mainly exploratory. The division has acquired a range of standard tractors, machines and implements, and these are being studied to see how far they are adequate for their purpose. In particular, data is being collected on the capabilities of the various cultivating implements available, including inter-row cultivators, and

the process of silage-making, using a shredding machine to break up the crop being ensiled.

ANIMAL HEALTH

Policy

The object of this division will be to work in collaboration with the Animal Production division in the study of the physiology of normal, healthy cattle and livestock under the conditions existing in the Accra Plains. The work will include studies of the physical and chemical properties of the blood of normal cattle, and the variations which occur under conditions of varying age, sex, pregnancy, lactation, breed and climate. The work will include questions of climatic adaptation in the tropics, water balances and heat tolerance.

Arrangements will also be made to test drugs, including new discoveries, in diseases which can safely be introduced to the station without fear of spreading infection to other stock.

The division has only recently come into being, and active work will begin as soon as buildings and staff are available.

ANIMAL PRODUCTION

Policy

In order to supplement by practical demonstration the course of formal lectures in Animal Production given at the College, it is intended to build up commercially suitable herds and flocks which have significance or are likely to have significance in Gold Coast economy. In effect this will involve the establishment of herds of beef-and dairy-cattle, mutton-sheep, pigs for pork and bacon, poultry for meat and eggs, and possibly goats.

Some of the experimental projects which will be tackled when buildings and facilities are available include:

- (a) Measurement of heterosis in pigs and poultry;
- (b) Line and in-breeding studies, using hybrid material from the sheep and poultry flocks;
- (c) The evolution of new hybrid races of sheep;
- (d) The selection of dairy-type animals from indigenous shorthorn and Sokoto breeds;
- (e) Nutrition studies with beef cattle, using, in the main, home produced fodder and silage.

Work In Progress This Year

A flock of Gold Coast forest sheep is being built up, and the nucleus of a herd of Large White pigs has been acquired, but little more can be done until there are more buildings, some of which, it is hoped, will be erected this year.

CROP PRODUCTION

In this division, work falls into two sections, crops and grassland.

Crops—Policy

The work will be to show and teach students the elements of crop husbandry by allowing them to do practical work on the station, and to find:—

- (a) The best crops to grow, and ways of improving them by selection and breeding;
- (b) The best methods of growing, harvesting and storing the crops;
- (c) The reasons for the lack of success of certain valuable crops in the area;
- (d) The best practicable large-scale methods of insect pest and disease control;
- (e) The best systems of irrigation for the crops and soil types of the Accra Plains.

Crops—Work In Progress This Year

The experiments have been planned in the light of preliminary trials made last year, in which ground-nuts, soya beans, cowpeas, sorghums and cotton showed promise as cash or food crops; *Crotalaria* spp., *stylosanthes* sp., and *centrosema* sp. were promising leguminous covers, and late millet cut green and annual and perennial pennisetums and *melinis* sp. were promising grasses.

In all experiments, the land has been treated with 2 cwt per acre triple superphosphate, and 1 cwt per acre sulphate of ammonia is given as a top dressing where necessary. Crop and soil analyses will be used to help interpret the results where profitable.

EXPERIMENT P1 PLANT INTRODUCTIONS.

Object:—

To try out on a small scale large numbers of local and introduced crops under dry land and irrigated conditions.

Soils:—

Grey sands and dark clays.

Treatments:—

Crops are planted in single rows.

Crops:—

Crops are annual and perennial grains, pulse, vegetable, fruit, fibre, oil, sugar and starch plants.

EXPERIMENT P2 MAIZE RUST RESISTANCE TRIAL**Object:—**

To test out numerous local and introduced varieties of maize for resistance to *Puccinia polysora*.

Soils:—

Grey sands

EXPERIMENT P3 VARIETY TRIALS**Object:—**

To find the best yielding varieties of promising staple food crops under dry land conditions.

Soils:—

Grey sands and dark clays

Crops:—

Maize, ground nuts, soya beans.

Design:—

Randomised blocks. 5 replicates.

EXPERIMENT P4 SPACING TRIAL**Object:—**

To find the best spacing for promising annual crops under dry land conditions. This experiment will later be extended to irrigated land.

Soil & Crops:—

Grey sands—maize, sorghum, soya beans, groundnuts
Dark clays—maize, sorghum, soya beans, cotton.

Treatments:—

EIGHT

3 spacings for each crop.

Design:—

3 x 3 latin square. 2 replicates.

EXPERIMENT P5 ROTATION TRIAL

Object:—

To test rotations having two harvested crops in one year on dry land.

Soils:—

Grey sands and dark clay.

Treatments:—

- (a) Crotalaria juncea, millet (for seed), millet (cut green), sorghum, natural fallow, to be planted in the early season and followed by a test crop of sorghum in the late season;
- (b) as above with seasons reversed.

Design:—

5 x 5 Latin square for (a) and for (b).

EXPERIMENT P6 ROTATION TRIAL (ONE CROP PER ANNUM)

Object:—

To test rotations having only one harvested crop in each year on dry land.

Soils:—

Grey sand and dark clay*

Treatments:—

Year	Series A		Series B	
	1	2	1	2
(a)	Sorghum	Soya	(a) Maize	G-nuts
(b)	Soya	Sorghum	(b) G-nuts	Maize
(c)	Sorghum	Sorghum	(c) Maize	Maize
(d)	Soya	Soya	(d) G-nuts	G-nuts

Design:—

Each series in a randomised block with 4 replicates.

*On the dark clay cotton replaces ground-nuts.

RAINFALL

YEAR						
	January	February	March	April	May	June
1944	4 1.92	1 1.29	9 4.13	3 2.77	13 5.10	11 12.3
1945	2 0.46	3 1.94	6 3.00	3 3.28	1 0.43	7 3.0
1946	1 0.04	3 1.97	4 2.35	7 1.83	10 6.31	1 0.0
1947	3 0.64	1 0.34	5 3.20	3 3.53	5 2.42	1 0.0
1948	nil nil	1 1.33	1 0.48	6 3.06	11 7.96	9 4.0
1949	nil nil	1 0.20	2 2.66	1 0.13	3 0.94	14 6.0
1950	2 1.06	1 0.59	6 3.20	5 5.46	8 4.84	nil nil
1951	1 0.10	nil nil	6 2.91	4 0.47	12 5.82	7 3.0
1952	1 0.28	4 3.96	8 4.99	2 0.75	8 6.04	14 11.0
1953	1 0.53	3 2.06	3 1.46	4 2.63	6 3.81	10 2.0
Mean	1.5 0.50	1.8 1.37	5 2.84	3.8 2.39	7.7 4.37	7.4 4.0

The first figure in each column denotes the number

—NUNGUA

N T H						TOTAL
July	August	September	October	November	December	
3.17	2 0.41	1 0.81	4 2.98	1 0.25	3 2.02	56 37.76
0.23	3 1.41	4 1.20	9 2.63	5 1.50	1 0.26	51 19.88
nil nil	1 0.09	4 1.84	4 0.94	4 0.51	4 1.53	43 17.70
4 2.32	7 1.94	16 8.21	4 1.65	5 6.28	5 2.38	59 32.93
2 0.38	nil nil	1 0.06	4 0.97	4 2.06	1 0.30	40 21.24
7 4.51	3 0.94	5 3.61	8 3.72	2 0.32	2 0.64	48 23.07
5 2.52	3 0.03	1 0.02	3 0.36	4 1.82	1 0.71	39 20.61
1 0.05	2 0.91	1 0.09	9 4.04	2 2.42	2 0.70	47 20.68
nil nil	nil nil	9 1.80	8 3.57	5 1.27	3 1.01	62 35.30
8 2.86	4 0.38	3 0.76	7 5.43	1 0.04	nil nil	50 22.68
8 1.60	2.5 0.61	4.5 1.84	6 2.63	3.3 1.65	2.2 0.95	49.5 25.28

ays on which it rained, and the second the rainfall in inches.

EXPERIMENT P7 (Commencing September) GREEN MANURE TRIAL

Object:—

To study the effects of numerous green manures grown in the late season on the fertility of the soil, using sorghum as a test crop in the following year under irrigated and dry land conditions.

Soils:—

Grey sands and dark clays

Treatments:—

Final details of the legumes and grasses have not been settled yet. In one series the green manures will receive phosphate and in the other none.

EXPERIMENT P8 (Commencing September) PHOSPHATE ABSORPTION BY GREEN MANURES

Object:—

To determine whether it is better to apply phosphates to

- (a) a green manure crop or
- (b) a given crop grown in rotation on dry land.

Soils:—

Grey sands and dark clays.

Treatments:—

Green manures—Crotalaria retusa)
Millet) Planted late
Natural fallow) Season

Test crop of sorghum planted early season 1955.

Phosphate (a) 0.4 cwt P_2O_5 per acre to green manures
(b) " " " " " " " sorghum
(c) " " " " " " " both
(d) No phosphate to either.

Design:—

3 x 3 rectangular lattice. 3 replications.

Grassland—Policy

The grassland flora of the Accra Plains is not well known and there is no evidence on its quantitative and qualitative response to grazing, fire, fertilizing, or seasonal

variation in climate. The work of the division will begin at the lowest level with large-scale collection and identification of grasses and associated plants, first at Nungua and later throughout the Plains. The most promising grasses and legumes collected will then be planted in nursery plots on the two main soil types (sand and clay) under both irrigation and dry land conditions. Plants thought to be suitable for general or special uses will be developed for establishing hay crops, pastures, leys, etc.

A vegetation map of the farm will be made and suitable plots, protected from all forms of man-made disturbance, will be laid out to help determine the nature of the climax vegetation in the plains and to act as controls for experiments. In the natural grasslands, a series of experiments will be laid out to determine the effects of grazing, fire, fertilizing, cultural treatment, and combinations of these four.

Grassland—Work in Progress this Year

GRASS-LEGUME NURSERY

Object:—

To establish a wide series of grasses and legumes likely to be of agricultural importance on the Plains, and to use these as sources of seed and living plants for large-scale propagation.

Soils:—

Grey sands and dark clay.

Treatments:—

Irrigation and dry land. Fertilizer may be introduced later.

Design:—

Two blocks of approximately 2 acres each, one on each type of soil. Half of each block is irrigated and half will remain dry, except at initial planting, when irrigation water may be used. There are grasses and legumes on each type of soil and subject to each type of treatment. Individual plots are 10' square with space for paths and furrows between.

ECONOMICS

Policy

The division will make regular analyses of the detailed costs which the Farm Manager keeps for all operations in the Station. When it is known what agricultural systems may prove profitable on the Plains, their economics will be investigated by means of costing trials designed for this purpose.

SOIL CONSERVATION AND IRRIGATION

This division has had the task of planning the dam and the system of soil conservation on the Station.

The Reservoir and Dam

The dam was started in October 1953 and completed in March 1954 with a D4 caterpillar tractor and carry-all scraper. The cost was £2,500, or slightly over 2s. 0d. a cubic yard of earth. The wall is 1,460 ft long and has a maximum height of 16 ft. There is no clay core, the subsoil being considered sufficiently impermeable to ensure satisfactory watertightness. The reservoir will hold 400 acre feet of water and is now (May) half full. If an allowance of 6 ft of water is made for evaporation, 80 acre feet per annum will be available for irrigation. The catchment area is 14 square miles and is estimated to yield 750 acre feet of water a year. The dam should thus discharge in most years, though in a very dry year it may not fill.

The reservoir will be stocked with suitable kinds of fish, both to provide meat, and to suppress mosquito larvae.

Irrigation

The irrigation system is now being installed. Water will be pumped from an outlet pipe below the dam wall through a 6" delivery pipe to an elevated tank on the highest part of the Station. The tank will supply domestic and livestock requirements. Irrigation water will be taken directly from T-joints in the main delivery pipe.

Soil Conservation

On pasture land the object is to maintain as dense a cover of vegetation as possible to reduce the run-off and its erosive power. No other measures are considered necessary.

On the arable land a buffer bank has been constructed above the ploughed fields to prevent water debouching on to the land. In the ploughed fields themselves a series of narrow-based terraces are provided. Since the amount of

water that has to be carried by a terrace channel increases towards its discharge end, the terraces do not follow the true contour but are given an increasing gradient towards the discharge end. Here the maximum permissible velocity of the water is 2 ft per second. In field S, which provides a good example of this system, the vertical interval between terraces is 3.7 ft, a distance which, it is calculated, will suffice for a rainfall intensity of 4 ins per hour lasting half an hour. According to the records of the Meteorological Station at Accra Airport, such an intensity will be reached only once in 15 years.

Where the slope of the land is less than 2 per cent, a simpler system of protection by grass strips is used—in field A, for example. Ploughing is done between parallel strips of grass, 6 ft wide. Silt carried off the ploughed land settles along the upstream side of the grass strips and gradually terraces will be built up. Besides being cheap, this system has the advantage that the plough strips are all of equal width, whereas, on the machine-terraced land, the distance between the banks (measured at right-angles to the contour) is not constant because the contours are sometimes close together and at others far apart, which may seriously hamper cultivation.

Preliminary observations suggest that much further study of protection and drainage is needed for the very erodible grey sands, and several more systems are being tried.

SOIL SCIENCE

Policy

The Division has the task of investigating the nutrient status and the physical conditions of the soils of the Plains under both irrigated and dryland conditions. In the field of soil nutrition, results of fertilizer experiments on natural grassland, carried out in 1953, indicate that the Nungua soils are deficient in nitrogen and phosphorus. Studies will, therefore, be directed to finding the most economical use of phosphoric and nitrogenous fertilizers in crops that can be expected to give profitable returns. Of these, fodder crops, which include natural grassland, will play an important role. Such questions as the most economical dressings, the method and time of application of the fertilizers, await answers. Attention will also be given to other elements, and the long-term effects of continuous applications of inorganic fertilizers will be studied.

The physical condition of the soil equally deserves attention. Detailed studies will be made of the effect of cropping systems and cultivations on the drainage and retention of water in the soils, under dryland and irrigated conditions. Field experiments will be the basis of this research programme, but, whenever necessary, laboratory investigations will be undertaken to illuminate any problems that may arise.

Work in Progress this Year

Work is being concentrated on the natural grassland, until more experience of suitable crops and their cultivation becomes available.

EXPERIMENT S1 NP EXPLORATORY TRIAL ON NATURAL GRASSLAND

Object:—

To test the effect of harrowing and of adding nitrogen and phosphorus on the natural grassland. The trial was begun in 1953.

Soil:—

Grey sand.

Treatments:—

N 2 cwt per acre, sulphate of ammonia

P 2 cwt per acre, superphosphate

H Harrowing once with Ferguson tandem disc harrow

Design:—

2⁵ factorial. 4 replicates.

Comments:—

This year the residual effects of the 1953 treatments are being assessed. The following conclusions were reached at the end of 1953 :—

Nitrogen alone increased the first cut of dry hay by 670 lbs per acre and the second cut by 471 lbs per acre.

Phosphorus alone decreased the first cut by 77 lbs per acre and increased the second cut by 84 lbs per acre.

Nitrogen and phosphorus together increased the first cut by 1593 lbs per acre and the second cut by 658 lbs per acre.

Harrowing reduced yields in the first cut and slightly raised them in the second cut.

The yield on untreated land was 1036 and 470 lbs per acre in the first and second cuts.

EXPERIMENT S2 NP EXPLORATORY TRIAL ON NATURAL GRASSLAND

Soil:—

Dark clays.

Comments:—

Identical with experiment S1 except that no second cut was taken in 1953. The main conclusions were:—

Nitrogen alone increased the first cut by 511 lbs per acre.
Phosphorus alone decreased the first cut by 211 lbs per acre.

Nitrogen and phosphorus together increased the first cut by 698 lbs per acre.

Harrowing decreased the yield.

The yield of the first cut on untreated land was 1834 lbs per acre.

On the dark clays mechanical mowing is impossible because of the tussocky nature of the surface.

EXPERIMENT S3 RATES OF N AND P ON NATURAL GRASSLAND

Object:—

To determine the effect of different rates of application of sulphate of ammonia and super-phosphate on the yield and nutritive value of natural grassland.

Soil:—

Grey sand.

Treatments:—

N0 no nitrogen fertilizer.

N1 $\frac{1}{2}$ cwt of sulphate of ammonia per acre.

N2 1 cwt of sulphate of ammonia per acre.

N3 2 cwt of sulphate of ammonia per acre.

P0 no phosphate.

P1 $\frac{1}{2}$ cwt of superphosphate per acre.

P2 1 cwt of superphosphate per acre.

P3 2 cwt of superphosphate per acre.

Design:—

Nitrogen and phosphorus treatments combined factorially in 5 4x4 balanced lattice squares.

EXPERIMENT S4 RATE OF N AND P ON NATURAL GRASSLAND

Soil:—

Dark clays.

Comments:—

Details as for experiment S3, but rates of application are doubled.

EXPERIMENT S5 LONG RANGE EXPLORATORY FERTILIZER EXPERIMENT ON NATURAL GRASSLAND

Object:—

To study the effects on the soil of continued application of farm yard manure and inorganic fertilizers.

Soil:—

Grey sand.

Treatments:—

- (1) nil
- D 8 tons per acre of farmyard manure.
- N 2 cwts per acre of sulphate of ammonia.
- P 1 cwt per acre of triple superphosphate.
- K 1 cwt per acre of sulphate of potash.

Design:—

2⁴ factorial. The design is arranged so that two further treatments may be added if required.

EXPERIMENT S6 LONG RANGE EXPLORATORY FERTILIZER EXPERIMENT ON NATURAL GRASSLAND

Soil:—

Dark Clays.

Comments:—

Details as for experiment S5

EXPERIMENT S7 BARE FALLOW TRIAL

Object:—

To find whether water may be stored in the soil by bare fallowing, and if so whether yields are improved.

Soil:—

Dark clay.

Crops:—

Sorghum in early season. Millet cut green in late season.

Treatments:—

Year		1		2	
		Early	Late	Early	Late
Rotations W	b	b	b	b	c
(A series) X	c	c	c	c	c
Y	b	c	b	b	c
Z	c	b	b	b	c

b=bare fallow. c=crop.

In the (B series) rotations, the treatments in the early and late seasons are reversed.

Basic fertilizer: 2 cwts sulphate of ammonia per acre and 1 cwt triple superphosphate per acre.

Design:—

Randomized blocks. 4 replications.

EXPERIMENT S8 LAND PREPARATION EXPERIMENT

Object:—

To compare the effects on the soil and crops of different methods of preparing the land.

Soil:—

Dark clay.

Crop:—

Sorghum

Treatments:—

- (a) Ploughing 6" v. 12".
- (b) Mould board v. disc. ploughing.
- (c) Subsoiling v. no subsoiling.
- (d) Tie ridging v. ordinary ridging.

In all combinations there are 16 different treatments. Basic fertilizer: 2 cwt per acre sulphate of ammonia and 1 cwt per acre of triple superphosphate.

Design:—

2⁴ factorial. 4 replications.

ZOOLOGY

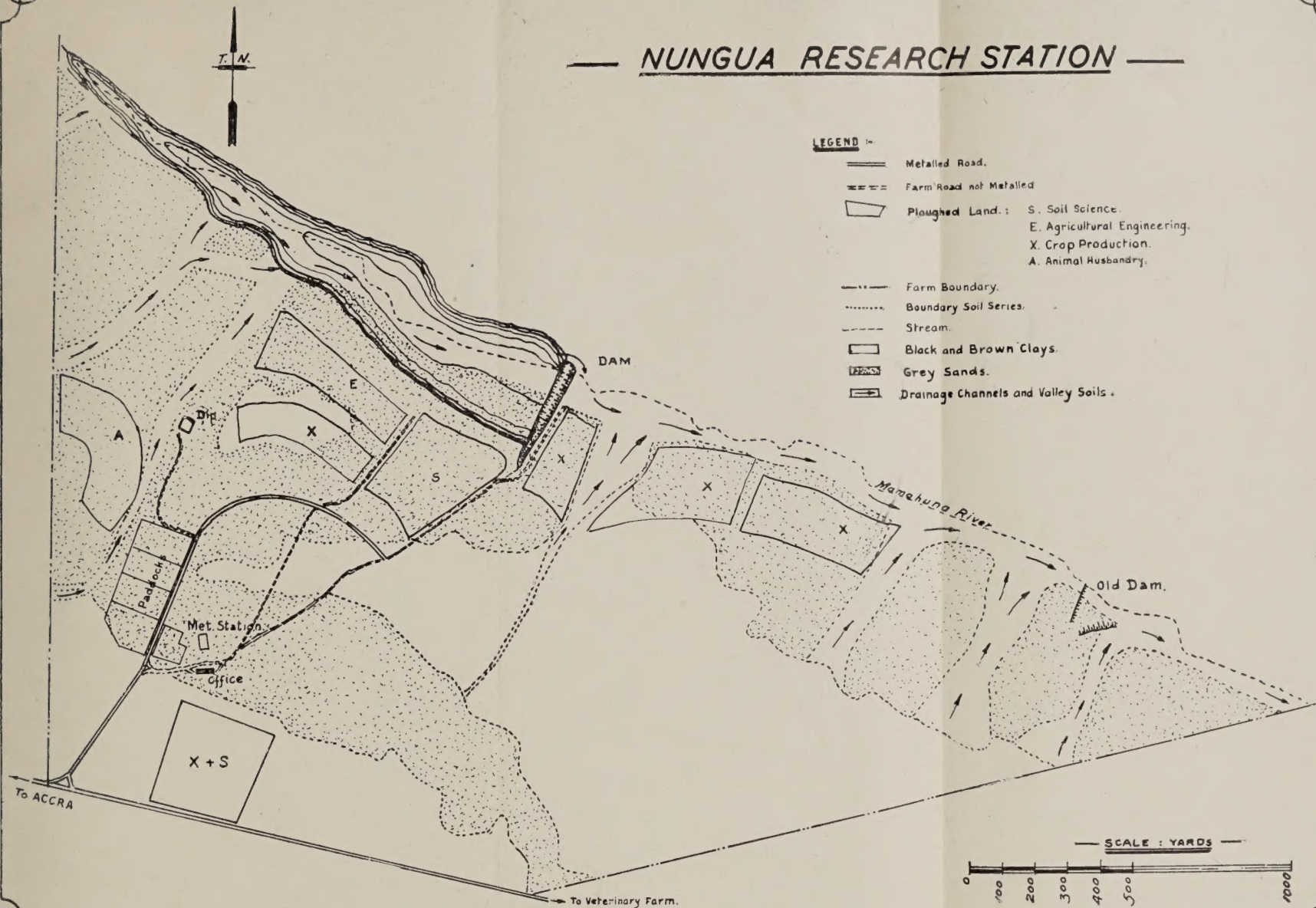
The University College Department of Zoology is making a special study on *Aphis laburni*, an insect vector of rosette diseases in groundnuts. It seems that the occurrence of 'rosette' diseases is likely to be an important factor in the success or failure of any large-scale cultivation of groundnuts on the Accra plains. Although a field may be seriously infected, the disease is often absent from even moderately large stands. It may be, therefore, that the initial period of infection is limited in its intensity or duration or both. In order to investigate this matter it is necessary to study the biology and ecology of the insect vector, *Aphis laburni*, as it occurs in the Accra plains.

A preliminary field experiment is in progress at the Station. Small plots of groundnuts are being planted at monthly intervals from May until October, and the development of aphid colonies and rosette disease on these plots is being noted. It is expected that this experiment will give some indications of the lines of research most likely to be profitable in future investigations.

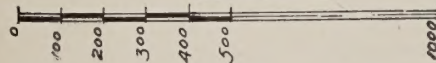
— NUNGUA RESEARCH STATION —

LEGEND :-

-  Metalled Road.
-  Farm Road not Metalled
-  Ploughed Land. : S. Soil Science.
E. Agricultural Engineering.
X. Crop Production.
A. Animal Husbandry.
-  Farm Boundary.
-  Boundary Soil Series.
-  Stream.
-  Black and Brown Clays.
-  Grey Sands.
-  Drainage Channels and Valley Soils.



SCALE : YARDS



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UNIVERSITY COLLEGE OF THE GOLD COAST.
Faculty of Agriculture.

THE SOILS OF THE NUNGUA RESEARCH STATION.

A brief outline of the findings up till August, 1954.

F. Hagenzieker.

The preliminary results of an as yet not completed, soil survey have lead to the recognition of at least three and possibly four different series.

Soil fertility studies through field experiments, have been confined, up till now, mainly to one group of soils the grey sands. Only one fertiliser experiment was conducted on the clays.

1. The Clays.

The typical profile shows a homogeneous soil mass of some 3ft. thick, rapidly fading into a horizon full of calcium carbonate concretions. This horizon varies in thickness from a few inches to about 3ft. From below, decomposed rock enters the carbonate horizon. Solid rock is struck at depths of 5ft. or more, depending on the thickness of the horizon of weathered rock, which underlies the calcium carbonate.

The first 3ft. consist of a relatively heavy clay. Small calcium carbonate and pisolitic iron concretions, as well as fragments of quartz are found throughout the whole of these 3ft. On the soil surface the concretions and quartz fragments tend to accumulate, as the surrounding clay is washed out by rain.

During dry periods the clay shrinks considerably. A network of big cracks, reaching down towards the calcium carbonate horizon, divides the soil into sharply edged clods. The first rains readily find their way down through those cracks, taking with them some loose, fine surface material. This preliminary wetting causes the clays to swell. All the cracks close and percolation cease. Further rain turns the ploughed layer into a sticky paste that can be worked only with the greatest difficulty. Eventually, both on the ploughed land, and on land still under its natural grass cover, puddles are formed, and surface runoff takes place. Improvement of the inherent drainage conditions of the profile through sub soiling is bound to be a failure. Also, little success can be expected from the system of so called broadlands. Cultivations can only be carried out successfully during a limited time, when the soil is neither too wet nor too dry. In order to dispose of the surplus water that cannot be taken in by the profile, it would appear best to throw up ridges under a slight gradient. Another advantage of these may be that, through increasing the surface area of the soil, they increase the evaporation and shorten the time, following heavy rains, at which cultivations can be started.

It will be appreciated that the sequence of events, described above, leads to a complete turnover and a perfect homogenisation of the soil, to a depth of some 3ft., through which the cracks are found. Fencing poles and foundations for buildings will have to avoid the effects of the ever-moving upper layers.

The swelling and shrinking of the clays, together with the binding action of the grass roots has led to a very uneven surface, making mechanical mowing of the natural grassland impossible. Tufts of grass of some 12 inches in diameter are separated from one another by sunken bare patches of clay that have approximately the same dimensions.

Both brown and blackish grey clays are found. It would appear that the brown clays are better drained than the blackish grey ones. In many places the difference in colour is hard to recognise. Wherever the brown clays suffer more than is usual from waterlogging, as in the drainage channels, the colour tends to take a blackish grey hue.

Profile studies have shown the brown clays to overlie a basic gneiss, which would appear to be the parent material of this soil. In a profile pit dug in the blackish grey clays, weathered rock was found from 6ft downwards. At a depth of 12ft solid rock had not been struck yet. In the deeper layers of the weathered material, especially in parts more resistant to weathering, the original rock structure was well preserved. These more resistant pieces, in appearance were rather similar to the rock underlying the grey sands, which has been recognized as an acid shist. The highly weathered parts were very micaceous.

On the brown clays, in and near the main drainage channels, a distinct form of microrelief has been found. The soil surface lies in "ridges" of about 6ft wide which are separated by "furrows" of approximately equal width. The phenomenon runs perpendicular to the contour lines. The vertical distance between the top of the "ridge" and the bottom of the "furrow", does not exceed one foot. The ridge is somewhat lighter in texture than the "furrow", which is clearly shown by the absence of cracks on the ridge as against the heavy cracking in the "furrows". Calcium carbonate concretions are scattered over the surface of the "ridge" but do not occur on the surface of the "furrow". In the "furrow" a certain amount of organic matter, washed down from higher lying grounds, accumulates after every rain storm that has caused runoff. At the onset of the rains, nitrogen is released by mineralisation of part of this organic matter. The effects of these processes are exhibited particularly well in areas that are burned. The regrowth of the natural grasses starts on the "ridge". Though relatively lower lying, in the first week of the rainy season the "furrows" are dryer than the "ridges". The explanation for this lies in the fact that in the "furrows" the first rains all disappear through the net work of cracks into the deeper soil-layers beyond reach of the grass roots. Possibly also the higher wilting point of the "furrow" clays retards the regrowth of the grass. When the grass in the "furrows" does start to grow again it shows up green in comparison with the "yellow" grass growing on the "ridge". The difference is only noticeable in the first week. After some time the grasses in the "furrows" look as nitrogen deficient as those growing on the ridge and on any other soil. Apparently the extra supply of nitrogen in the "furrow" is still insufficient for an optimum performance of the grass throughout its life cycle.

Big deviations from the general description of this group of soils, given above are found. An increase in the content of coarse material leads to a noncracking clay. In patches iron concretions are so frequent as to compare almost the entire soil mass. The clay has a reddish tinge and the concentration of the concretions may be so high that they form a blanket covering the soil surface. The vegetation is reduced to a few stunted grass tufts. Away from the centre of the patch the number of concretions gradually decreases till through a noncracking clay, the typical heavy cracking clay is found again.

A fertilizer experiment conducted on the blackish grey clay, with the natural grass as an indicator crop confirmed the visual observation of nitrogen deficiency (Xpt. S2). In the first cut an extra 511 lbs. of hay were harvested as the result of an application of 2 cwt. of sulphate of ammonia. The application of 2 cwt. of granulated single super reduced the hay yield by 212 lbs. When both fertilizers were present a yield increase of 698 lbs. was registered. The "nil" yield, that is to say the yield of hay without any fertilizers being applied, came to 1834 lbs. All weights, refer to an acre basis. Unless stated otherwise, this holds true for all the quantitative data that are quoted in this script.

The experiment also included a harrowing treatment. Whether fertilizers were absent or present, harrowing reduced the yield. The effects were more pronounced in the absence than in the presence of fertilizers, the reduction in yield through harrowing being less in the presence of sulphate of ammonia than superphosphate, and least of all in the presence of both.

2. The Grey sands.

The underlying acid shist is clearly the parent material of this soil series. Quartz veins are of frequent occurrence in the shist. They give birth to angular stones of some 3" in diameter. Both bigger and smaller pieces may be found. In addition to this, rounded, water-worn stones, which presumably are the remains of former beach terraces, occur. Depending on their age the stones are more or less stained with iron compounds.

Wherever the shist contains enough minerals that may undergo intensive chemical weathering, sufficient clay is formed to build up a pan. This pan is a typical illuvial horizon and rests directly on the solid rock. A layer of decomposing rock has not been found. The colour is mainly grey but may have a reddish tinge, depending on the state of oxidation of the iron compounds present. A greyish clod soon turns rusty when dug up and exposed to the air. In places where the shist is fissured the clay enters the cracks. The stones, mentioned above, rest on top of the clay.

The process of eluviation has left a top layer of light grey fine sand. Of course, the less clay the acid shist produces, the less noticeable becomes the effect of ~~eluviation~~ eluviation. In extreme cases, when no ~~eluviation~~ eluviation seems to have taken place at all, the fine sandy layer directly overlies the parent material or is only separated from the shist by the layer of stones. In other cases the effects of eluviation are to be traced only by a slight increase in clay content with depth. The top 6" are dark grey through the presence of some organic matter. In the bottom portion of the sand horizon a red mottling may often be seen. This indicates a frequently changing water table. The "gley" phenomena are seen more clearly displayed in the top part of the clay horizon. A distinct red and blue mottling can be observed here.

As yet nothing has been said about the thickness of the main three horizons. It must be appreciated that the profile varies considerably over even short horizontal distances. Especially the clay horizon and the stone line are developed very irregularly. They may be a few feet thick; sometimes one or both of them are missing completely; in general the fine sandy horizon does not exceed a thickness of some 3ft. This holds good for soils that

are situated on the higher grounds. Lower down the slope the horizon becomes increasingly thinner, till at the lowest part the underlying clay pan almost touches the surface. In those places the clay is never absent. It would appear that a considerable portion of this clay has originated higher up the slope and is washed down with seepage water.

Profile studies clearly indicate the grey sands to be poorly drained. Observations made after heavy rain confirm this. The fine sand turns into a mud, preventing agricultural operations. The drying up requires many days and because of the great variation in the composition of the profile over comparatively short horizontal distances, takes place very unevenly. Often pockets are found that require a much longer time to dry out than the surrounding area. In general, the toplands stay wet much longer than the lands at the lower end of the slope. Considering the difference in thickness of the fine sandy horizon between the high and the low grounds this was to be expected. Excessive rain must find its way down by surface runoff. This runoff tends to follow a definite route along which the soils are to be recognized by a higher clay and organic matter content.

Variation to the characteristic grey sand profiles, as described above, are not uncommon. Near the stream calcium carbonate concretions have been found in the upper part of the clay horizon. Iron concretions occur anywhere the drainage is relatively good. Isolated pockets, that suffer more from temporary excess of groundwater than the remainder of the soil series often have a higher organic matter content in the top soil. Termitaria are composed almost entirely of clay, similar to that found elsewhere in the profile.

The classical anti-soil erosion measures of terracing and ridge planting do not appear to be very satisfactory. This, to a great extent, is caused by the disturbing effects of the termitaria. Apart from the practical difficulties encountered in constructing the terrace banks and planting on ridges that run nearly on the contour, the excessive runoff from the termitaria leads to breakages which cause severe gully erosion. It seems imperative that any land reclamation on the grey sands should start with the flattening and levelling of the termitaria. But even if this is done and breakages have been eliminated completely the system is still far from ideal. Drainage takes place very slowly, and the severe water logging after heavy rains greatly hampers agricultural operations. It is thought that conditions can be much improved by constructing so called "broadlands". These virtually are broadbased terraces with an interval between each that has been reduced to only a drainage channel. The gradient must be sufficiently steep so as to permit quick drainage, but not too steep, in order to avoid severe gully erosion of the channel. As far as topography permits the broadlands are laid out parallel to one another. Correction strips are put in when and wherever the diversion from the chosen gradient is becoming too big. The optimum width of the broadlands is thought to vary around 30ft. They can be easily constructed without much additional cost by ploughing alternatively up and down hill. With the "broadlands system" contour banks are not required, so that the total costs of land-preparation will be less than with the classical methods of protection.

On these soils an exploratory fertilizer experiment has been conducted on natural grassland (Exp. S₁). Contrary to the clays, the grey sands have a very even surface and mowing can be easily done by machine. The treatments of the experiment consisted of : a dressing of 2 cwt of sulphate of ammonia (n), one of 2 cwt. of granulated single superphosphate (p) and a harrowing treatment (h) in all possible combinations. As on the clays (Xpt. S₂), in the first cut the harrowing treatment had a depressing effect on the yield. In the second and third cut this depressing effect lasted if both the fertilizers were applied. With only one of the two artificials present, small ~~de~~creases as well as increases in yield were recorded. In the absence of any fertilizers both in the second and in the third cut yield increases were obtained through harrowing, but these increases were not sufficiently big to counter balance the loss incurred in the first cut. Summarising it may be concluded that harrowing of the natural grasslands both in the absence and in the presence of fertilizers results in yield losses.

Superphosphate, applied by itself, only slightly influences the yield. Its beneficial effect is revealed only in the presence of a dressing of sulphate of ammonia. The total hay yield after three cuts was then raised from 2615 to 5420 lbs. Sulphate of ammonia alone raised the yield to 4,000 lbs., whereas super alone only increased the yield to 2712 lbs. The main contribution to these total n and np effects came from the first cut : viz. yield increases of respectively 65 and 155, as expressed in percentages of the nil yield. But even in the third cut, 56 weeks after the fertilizers had been applied, the effects were still appreciable : 22% for the n and 50% for the np effect. The grey sands obviously are very poorly supplied with both plant available phosphorus and nitrogen. As for the latter, this was already indicated by the yellow colour of the grasses. Apparently, phosphate fixation, if any, is not serious enough to obstruct the beneficial effects of easily soluble phosphatic fertilizers.

Four rates of single superphosphate in all combinations with four rates of sulphate of ammonia were tried out on natural grassland in another two experiments (Expts. S₃ and S₄). For the first cut the grass and hay yields were found to climb consistently with increased dressings of sulphate of ammonia. At the highest rate of 4 cwt the highest yield had not been reached yet. No substantial differences were found between the effect of relatively low and high dressing of superphosphate. An application of one cwt. would appear to be sufficient. In combination with some 4 cwt. of sulphate of ammonia yields, four times the nil yield can be expected.

Arable crops respond as well to fertilizers as the natural grassland does. Sorghum failed to make any growth whatsoever if no superphosphate had been given. A dressing of sulphate of ammonia alone did not have any effect at all. On the other hand, a single application of superphosphate improved the performance of the crop remarkably well. Apparently the microbiological population also is in short supply of phosphates and nitrogen mineralisation in the ploughed up grass sod cannot take place unless phosphatic fertilizers have been used. The best results are to be expected from a combined dressing of nitrogenous and phosphatic fertilizers.

3. The valley and drainage channel soils.

These soils form a geographically associated soil complex. What they have in common is the fact that after heavy rains, they may be temporarily exposed to flood water.

At the upper end of the drainage channels and down towards the middle portion of the slope erosion may have led to gullying. This does not happen often and the gullies are all small; not more than a few feet wide and a foot or so deep. Gullying is confined mainly to the clays.

In the sands the main drainage channels are substantially wider than in the clays. Sedimentation takes place only at the lower end of the drainage channels. Consequently the soils of the upper part are much like the series in which the channel has been formed. Those of the lower end vary in composition from fine sands to stiff cracking clays, depending on the topography and the soils from which the drainage channel has brought down its deposits. Some of the clays are very much like the black clays, described before. The sandy types of valley soils are never very deep. As in the grey sands a clay pan is found at a few feet depth. Only in places along the banks of the stream where a levee has been ~~formed~~ are the top layers substantially thicker than in the grey sands. Usually such a levee is succeeded by a somewhat lower lying clayey soil, further away from the stream. Thus, the natural soil sequence occurring in any plain where streams have lost their erosive powers may be seen. This does not imply that no stream bed erosion takes place. After heavy rain storms when the stream is running fast and surface water rushes down the drainage channels this certainly happens.

m.v. Nigerstroom
Takoradi to Amsterdam.

August, 1954.

C. C. T. A.

N° 5 A

Second Inter-african Soils Conference

PROPOSED PROGRAMME OF WORK FOR THE CONFERENCE.

Monday, 9th of August

MORNING

10 a.m. Opening Session of the Conference. Speech by the Governor General of the Belgian Congo. (Hall of the "Princess Astrid" Institute of Tropical Medecine).

AFTERNOON

2.30-4.45 p.m. Hall J PLENARY SESSION.

Adoption of the Agenda of the Conference.

Appointment of the Steering Committee of the Conference.

Appointment of the Workings Committees and of their Chairmen.

I) Committee for Soil Study.

a) Sub-Committee for Analysis and Research.

b) Sub-Committee for Classification and Cartography of African soils.

II) Committee for Soils Conservation.

III) Committee for Soils Utilization.

Appointment of Drafting Committee.

Appointment of Working Committees and meeting of these committees for the study and adoption of their Agenda.

4.45 p.m. Tea.

5.15 p.m. At the choice of the delegates:
Visit to the UTEXLEO factory.
Visit to a technical training school and to the St. Luc Art School.
Cinema show at the "Service de l'Information (films taken in the Congo)

(1) Reports to be presented at the Plenary Session or to serve as a basis for discussion, have been completely translated. Extensive summaries of other communications have been made by the Technical Secretariat and translated, in order to enable delegates who are not familiar with the language of the author to follow his exposé. This Programme of Work includes only those subjects on which communications have been submitted or announced. Chairmen of Sections may, if they consider desirable, allow the discussion of subjects on the programme of the Conference, not included in the present Programme.

TUESDAY, 10th AUGUST, 1954.

(2)

MORNING

Plenary Session (Hall J.)

Review of the results obtained in the implementation of the Recommendations of the Goma Conference.

- 8-9.45 a.m. Report of the B.I.S. Discussion: Means of increasing the efficiency of B.I.S. - Possible scope.
Report of the S.P.I. (N°70) Discussion: Possible scope.
- 9.45-10 a.m. Coffee
- 10-a.m.-12.30 pm. Reports of the Regional Committees:
(a) S.A.R.C.C.U.S. (N° 95)
(b) C.R.A.C.C.U.S. (N° 2)
(c) West African Committee (N° 1)

Discussion of these Reports.

AFTERNOON

Joint Session (Hall J)

of the Committees for Conservation and for Utilization of soils.

Review of results obtained and progress accomplished in the conservation of soil, in the various African territories, since the Goma Conference.

- 2.30-4.45 p.m. -Progress of Soil Conservation in South Africa by P.D. HENNING. (N° 81)
-Soil Conservation Progress report (Basutoland) (N° 66)
-Report on the work accomplished by the Soil Survey Organisation (Gold Coast). (N° 98)
-Conservation des Sols au Togo (Lamouroux)
-Discussion of these reports.

4.45 p.m. Tea.

- 5.15 p.m. Choice of visits:
Visit to a technical training school and to the St. Luc Art School.
Visit to the Prehistoric Museum.
Visit to the Geological Museum (comments in French)

Committee for Soil Study. (Hall C)

- 2.30-4.45 p.m. -Submission of a Pedological Dictionary (J. LOZET). (N° 6)
-La recherche Pédologique et agrologique au Congo Belge de 1948 à 1954. (H. LAUDELOUT). (N° 105)
-Quelques aspects du rôle des laboratoires d'analyses et de recherches dans l'Etude des Sols Africains (J. D'HOORE S.P.I.). (N° 69)
-Progress of Soil Surveys in South W. Nigeria (H. VINE, V. WESTON). (N° 10)
-Surveys of Soil Investigation since the Goma Conference (Nyasaland). (N° 30)
-Preliminary ecological survey of Nyasaland. (N° 50)
-The value of limitation of soil survey (GETHIN JONES). N° 9
-Discussion of these reports.

Tea.

(Hall 1)

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5 p.m.

Choice of visits:

Visit to a technical training school and to the St. Luc Art School.

Visit to the Prehistoric Museum.

Visit to the Geological Museum (comments in French).

MORNING

WEDNESDAY, 11TH AUGUST, 1954.

(4)

Joint Session

of the Committees for Conservation and for Utilization of soils.
(Hall J)

8-9.45 a.m.

Review of the results obtained since the Goma Conference (continued)

- La Conservation et l'Utilisation des Sols du Congo Belge (A. de BOE). (N° 38)
- Report on the progress of Soil Conservation measures since the Goma Conference (Tanganyika) (N° 36)
- General progress report on work accomplished and results obtained since the Goma Conference (Northern Rhodesia). (N° 34)
- Review of Soil Conservation in Southern Rhodesia. (N° 40)
- Exposé succinct des travaux effectués par la Mission antiérosive depuis la Conférence de Goma (BECKMANN, KIEVERS). (N° 37)
- Discussion of the reports.

9.45-10 a.m.

Coffee

10 a.m.-12.30p.m. Continuation of the discussion.

Committee for Soils Study.

Sub-Committee

Analysis and Research. (Hall C)

8-9.45 a.m.

Discussion and Adoption of protocols for the Analysis of African soils.

- Presentation and discussion of the S.P.I. Memorandum (see document)
- Methods of analysis used by STAT (France) -(see document)
- Analytical methods used in the laboratory of soil and land-use survey (A.S. DE ENDREDY). (N° 75)
- Methodes d'analyses utilisées actuellement aux Laboratoires des Sols de l'I.D.E.R.T. (G AUBERT, C. OLLAT, M. PINTA). (N° 101)

9.45-10 a.m.

Coffee.

10 a.m.-12.30 p.m.

Continuation of the discussion.

Sub-Committee

Classification and Cartography. (Hall D)

8-9.45 a.m.

Suggested classification of African soils.

- Charaterization and standardization of terms used.
- Sur quelques questions de nomenclature des sols des régions tropicales (J.V. BOTELHO DA COSTA) (N° 84)
- Report on the progress of the survey and classification of Tanganyika Soils. (N° 8)
- A basis of classification of the soil of areas of composite topography in Central Africa, with reference to the Soils of the Southern highlands of Tanganyika (A.M. SPURR). (N° 7)

9.45 a.m.

Coffee

10 a.m.-12.30pm. Continuation of the discussion.

WEDNESDAY, 11TH AUGUST, 1954
The Committee for Conservation of the Forests of the Congo

Report of the Committee for Conservation of the Forests of the Congo (No. 38)

The Committee for Conservation of the Forests of the Congo (No. 38) has the honor to acknowledge the receipt of the report of the Committee for Conservation of the Forests of the Congo (No. 37) dated 10th July 1954. The Committee has considered the report and has decided to recommend that the report be adopted with certain amendments. The Committee has also decided to recommend that the report be published in the form of a brochure.

Continuation of the discussion.

11th August 1954

Report of the Committee for Conservation of the Forests of the Congo (No. 38)

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Continuation of the discussion.

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Continuation of the discussion.

AFTERNOONSoils Conservation Committee. (Hall A)

- 2.30-4.45 p.m. Methods and means used in the control of erosion.
- Méthode et moyen de lutte employés contre l'érosion (A. DUBOIS). (N° 46)
 - Méthode et moyen de lutte employés contre l'érosion en territoire d'Astrida (LANGUY. J.). (N° 47)
 - Note sur le Bureau des Sols en A.O.F. (GOUDY) (N° 35)
 - Note sur l'activité du Bureau de la Conservation des Sols de Madagascar et Dépendances (P. SABOUREAU). (N° 68)
- 4.45 p.m. Tea.
- 5.15 p.m. Choice of: Visit to the Public Works Department Laboratory.
or Visit to the Zoological Garden.

Soils Utilization Committee. (Hall B)

- 2.30-4.45 p.m. Planning and Utilization of Land.
- Les Missions de Planification du Congo Belge (INEAC). (N° 104)
 - Planning of land use and soil and water conservation in the Northern Territories (Gold Coast). (N° 90)
 - Review of soil conservation and land use planning in Native areas in Southern Rhodesia. (N° 35)
 - Activité du Groupe économie rurale (V. DRACHOUSSOFF) (N° 64)
 - Land Utilization and Soil Fertility maintenance in Kenya (C.C. WEBSTER).
- 4.45 p.m. Tea.
- 5.15 p.m. Choice of: Visit to the Public Works Department Laboratory.
or Visit to the Zoological Garden.

Committee for Analysis and Research (Hall J)

- 2.30-4.45 p.m. Discussion and adoption of protocols for the analysis of African soils.
- Continuation of discussion.
- 4.45 p.m. Tea.
- 5.15 p.m. Choice of: Visit to the Public Works Department Laboratory.
or Visit to the Zoological Garden.

Sub-Committee for Classification and Cartography. (Hall D)

- 2.30-4.45 p.m. Classification of African soils. (continued)
- Sur une Classification des sols de Delta soumis à l'influence saline du Bas Senegal (J. DUBOIS) (N° 97)
 - Normalisation de la caractérisation morphologique du sol en place (INEAC). (N° 72)
 - Un cas d'inversion apparente de la Catena de couleur tropicale (CH. SYS). (N° 20)
- 4.45 p.m. Tea.
- 5.15 p.m. Choice of: Visit to the Public Works Department Laboratory.
or Visit to the Zoological Garden.

MORNINGCommittee for Soils Conservation (Hall A)

- 8-9.45 a.m. Methods and means used in the control of erosion in the various African territories.
- Soil conservation in the native areas of the Union of South Africa (D.J. VAN DEN BERG). (N° 67)
 - Rapport sur l'état actuel de la conservation des sols en Territoire de la Haute Volta (J.DUBART). (N° 103)
 - Les problèmes de la conservation des sols au Niger et dans le Gao (CH. LEMAITRE). (N° 42)
- 9.45-10 a.m. Coffee.
- 10 a.m.-12.30 pm. Methods and means used in the control of erosion in the various African territories. (continued)
- l'action du Service Forestier en A.O.F. en matières de conservation des Sols (P. BELLOUARD). (N° 43)
 - Influence des divers peuplements de reboisement sur la régénération des Sols de Madagascar (M. PERNET). (N° 86)
 - Discussion.

Committee for Soils Utilization. (Hall B)

- 8-9.45 a.m. Methods of utilization of tropical soils - Transformation of traditional systems of agriculture.
- Progress of work on the Management of the Soil since 1948 (H. VINE, V.J. WESTON). (N° 82)
 - Méthodes d'utilisation des sols agricoles et leurs perfectionnements (J. CLEMENT). (N° 48)
 - Department of agricultural and veterinary services Somaliland Protectorate report (J.M.WATSON). (N° 45)
 - Village témoin de Vohitrarivo (P.VIGNAL). (N° 52)
 - Les petites irrigations: complément d'amélioration au système de cultures traditionnelles au Bwishaza (A. MONNOM). (N° 59)
 - Les pâturages de la province de Fianarantsoa (A. GILLARD). (N° 53)
 - Essai en commun de phytotechnie - INEAC -Yangambi. (N° 21)
- 9.45-10 a.m. Coffee.
- 10a.m.-12.30 p.m. Results obtained in trials of agricultural mechanization on a large scale.
- The Progress and Trials in the mechanization of African agriculture in Tanganyika (V.R. FUGGLES - COUCHMAN). (N° 59)
 - Essai pilote de Motoculture de la Ramie, au Cameroun (E. DE LAPERSOONE). (N° 54)
 - La culture mécanisée de l'Arachide en Afrique Française (C.G.O.T.). (document spécial)
 - Les problèmes de l'utilisation des sols à l'office du Niger (DABIN). (N° 92)
 - Note sur le Machinisme Agricole à Richard Toll (P. MARTINE). (document spécial)
 - Discussion.

RECEIVED
JAN 10 1964
U.S. DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF INVESTIGATION

TO : DIRECTOR, FBI
FROM : SAC, NEW YORK
SUBJECT: [Illegible]

Reference is made to New York airtel dated 1/8/64, captioned as above, and New York letter to Bureau dated 1/7/64, captioned as above. The Bureau is advised that the New York Office is currently conducting an investigation of the activities of the [Illegible] in the New York area.

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MORNING

THURSDAY, 12th August, 1954.

Sub-Committee for Analysis and Research (Hall J)

8-9.45 a.m. Protocols and methods of analysis. (continued)

- Séparation granulométrique quantitative à la super-centrifuge du type "Sharples" (EKKA et FRIPIAT) (N° 5)
- Analyse granulométrique représentation des résultats (J. CROEGAERT). (N° 4)
- Analyse granulométrique, examen critique de la méthode (CROEGAERT - KUCZAR). (N° 3)
- Signification de la fraction limoneuse dans quelques sols congolais (D'HOORE ET CROEGAERT). (N° 85)
- Valeur comparée des diverses méthodes de dosage des bases échangeables dans les Sols Tropicaux (STAT). (N° 80)
- Discussion.

9.45-10 a.m. Coffee.

10a.m.-12.30 pm. Continuation of discussion.

Sub-Committee for Classification and Cartography. (Hall D)

8-9.45 a.m. Suggested classification of Tropical soils. (cont.)

- Corrélation des Travaux - (INEAC - GER.). (N° 49)
- Discussion.

9.45-10 a.m. Coffee.

10a.m.-12.30 pm. Land Utilization Maps - Standardization of scales adopted.

- Les cartes d'utilisation des Terres (AUBERT et FOURNIER). (document spécial)
- Les cartes d'utilisation des Sols à Madagascar (J. RIQUIER). (N° 94)
- An experimental pedological map of Tanganyika (CALTON). (N° 11)
- Provisional Soil Map of Mozambique (D.H.V. GOUVEIA-A.L. AZEVEDO)
- Sur la Carte d'utilisation et sur la carte pédologique de la boucle Ogou - Mono (M. LAMOUREUX) (N° 76)
- Notes complémentaires sur la carte d'utilisation des Terres du Secteur Casamance de la C.G.O.T. (FAUCK). (document spécial)
- Prospection, cartographie et classification des sols Africains (J. D'HOORE). (N° 93)
- Deux exemples de l'utilisation de la photographie aérienne dans la cartographie des Sols au Congo Belge (A. WAMBEKE et VAN OOSTEN). (N° 71)

AFTERNOON

Visit to Brazzaville - leaving at 1.30 p.m.

THURSDAY, 12th August 1941

Continued from Analysis and Results

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FRIDAY, 13TH AUGUST, 1954.

(8)

MORNING

Committee for Soils Conservation. (Hall A)

8-9.45

Methods and means used in the control of erosion in the various African territories.

- Une méthode de mise en défens de savanes dans le territoire de Thysville s'appuyant sur la pratique coutumière des "Nkunku" (J. BIERNAUX). (N°65)
- The ridging as a means of soils and water conservation and of yield improvement (P.H. LE MARE). (N° 44)
- The Treatment of freshets as part of the Run-off control (J.J.O. PAZZI). (N° 88)
- Discussion.

9.45-10 a.m. Coffee.

10a.m.-12.30 pm. Continuation of the discussion.

Committee for Soils Utilization. (Hall B)

8-9.45

Use of Fertilizers and other improvements.

- A review of recent trials with fertilizers in Uganda (W.R. MILLS). (N° 89)
- Soil fertility experiments, Northern Rhodesia (1950-53) (E. PAWSON). (N°27)
- Fertilizer experiments with maize in South Africa (J. VAN GARDEREN). (N° 61)
- Crop responses to fertilizers and manure in Zanzibar (G.E. TIDBURY). (N° 56)
- The use of phosphate fertilizers in Sierra Leone (C.J. PIGGOTT). (N° 60)
- L'emploi des phosphates de Thiès dans l'agriculture Sénégalaise (R. BOUYER) (rhoneotyped)
- La fumure du cotonnier en Uele (A. LANDELOUT, H. DUBOIS, G. DE PLAEN). (N° 79)
- Fertilisation des rizières des plaines du Haut Niger et de ses affluents en Guinée Française (H. VEROT). (N° 57)

9.45-10 a.m. Coffee.

- 10a.m.-12.30 pm.
- A fertilizer trial with Chloris guyana and the yield of a subsequent crop (W.R. MILLS). (N° 58)
 - Les sols du secteur cotonnier de Haute-Volta (JOEL LENEUF). (N° 78)
 - Le traitement des sols tropicaux schisto-calcaires par les explosifs agricoles au Bas Congo Belge (R. DEVRED). (N° 18)
 - Report Sierra Leone (Fertilizer Investigation) (N° 80)
 - L'utilisation des engrais en culture bananière (P. PELEGRIN).
 - Mise en valeur des sols marécageux (A. DUBON) (N°62)
 - Discussion.

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FRIDAY, 13th AUGUST, 1954.

MORNING

Sub-Committee for Analysis and Research. (Hall J)

8-9.45 a.m. The problem of lateritic hardpans, migrations, accumulations of sesquioxides.

- Le facteur Humain et l'accumulation des sesquioxides libres dans les Sols Tropicaux (J.D.HOORE). (N° 12)
- Etude Statistique des teneurs en Fe_2O_3 libre sur limon et argile pour les sols de trois régions naturelles du Congo Belge (J.D.HOORE). (n° 14)
- Quelques remarques sur les oxydes de fer fixés sur les argiles tropicales (J.L.HOORE, S.J.FRIPIAT, M.G. GASTUCHE). (N° 13)
- La fertilité des latosols du N.E. Du Congo Belge - La latérisation (A. de CRAENE). (N° 17)

9.45-10 a.m. Coffee.

10a.m.-12.30 pm. Discussion.

Sub-Committee for Classification and Cartography. (Hall D)

8-9.45 a.m. Study of various types of African soils.

LATOSOLS

- Latosols of Nigeria and some related soils (H.VINE) (N° 16)
- La fertilité des latosols du N.E. du Congo Belge et ses relations avec la morphologie du profil pédologique.
- La latérisation (A. de CRAENE). (N° 17)

HYDROMORPHIC SOILS.

Etude de quelques sols hydromorphes à engorgement temporaires de la région de Bargny (Senegal) (J. FAURE). (N° 15)

HIGHLAND SOILS.

- Exploration Pédologique du Ruanda Urundi.
- Contributions à l'étude des sols des hautes altitudes de l'Urundi (W. KUCZAROW). (N° 100)
- Les vallées sèches du Bugesera (R. FRANKART). (N° 73)
- Introduction à l'étude des sols de la région de Kitega (W.KUCZAROW). (N° 99)

9.45-10 a.m. Coffee.

10a.m.-12.30 pm. TROPICAL CLAYS.

Caracteristiques morphologiques des argiles tropicales de la vallée de la Lufira (A. VAN WAMBEKE et F. VAN OOSTEN). (N° 95)

VARIOUS SOILS.

- Essai d'interprétation nouvelle de la genèse de certains types de "stone-line" (A.deCRAENE et C.SOROTCHINSKY). (N° 32)
- Propriétés des sols dérivés de roches diabasiques (CH. SYS). (N° 19)
- Les principaux sols formés sur roches volcaniques

FRIDAY, 13th AUGUST, 1954.

MORNING

au Cameroun (A. LAPLANTE - G. BICHELIER). (N° 31)
- Les sols tropicaux formés sur calcaire et
l'origine des concrétions calcaires dans certains
sols d'Elisabethville (CH. SYS). (N° 77)

At the choice of the delegates:
Visit to the Museum of Prehistory.
" " " the Geological Museum (Lectures
in English)
Visit to the Geographical Museum of the
Belgian Congo.

Visit to the Museum of Native Life.
Cinema show at the "Service de l'Information"
(films taken in the Congo).

Joint Session of the Committee for Soil Fertilization and the
Sub-Committee for Analysis and Fertilization

2.45 p.m. Fertilization of African Soils - General Session
of Fertilization

- Report on the progress of the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

Joint Session of the Committee for Soil Fertilization and the
Sub-Committee for Analysis and Fertilization

Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

Joint Session of the Committee for Soil Fertilization and the
Sub-Committee for Analysis and Fertilization

Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

- Report on the work of the Sub-Committee for
Analysis and Fertilization

2.45 p.m.

AFTERNOONCommittee for Soils Conservation.

(Hall A)

2.30-4.45 p.m. Research on the various causes of erosion.

- Soil conservation versus agronomy and pedology (A.S. TEIXEIRA).
- Brief report on conservation research in hand and projected (Southern Rhodesia). (N° 39)
- Mesure de l'érosion et du ruissellement sous différentes cultures (P. ROCHE). (N° 41)
- Discussion
(These exposés could be submitted in the morning.)
(The Committee would then meet in Hall J jointly)
(with the Committee for Utilization and the)
(Sub-Committee for Analysis and Research.)

4.45 p.m.

Tea.

5.15 p.m.

At the choice of the delegates:

Visit to the Museum of Prehistory.

" " the Geological Museum (comments in English)

Visit to the Geographical Museum of the Belgian Congo.

8 p.m.

Visit to the Museum of Native Life.

Cinema show at the "Service de l'Information"
(films taken in the Congo).

Joint Session of the Committee for Soils Utilization and the
Sub-Committee for Analysis and Research. (Hall J)

2.30-4.45 p.m. Fertility of African Soils - Chemical Factors of Fertility.

- Etude sur l'apport d'éléments nouveaux résultant de l'incinération de la jachère forestière (H. LAUDELOUT). (N° 25)
- Immobilisation minérale et coefficient d'utilisations apparentes des engrais minéraux pour quelques cultures au Congo Belge (H. LAUDELOUT) (N° 23)
- Is the task of fertility of Tropical African soils exaggerated? (H. VINE). (N° 26)
- Les principaux sols formés sur roches volcaniques au Cameroun - Observations sur leur fertilité et leur exploitation agricole (A. LAPLANTE et G. BACKELIER). (N° 31)
- Minor elements in Uganda soils (E.M. RENERY). (N° 91)

Organic Matter and Humus.

- Organic matter and soil structure (H. KIINTWORTH) (N° 22)
- Le problème de l'humus dans l'utilisation rationnelle des sols de la vallée du Niari, en agriculture mécanisée (J.M. BRUGIERE). (N° 97)
- Contribution à l'étude des sols organiques de la région de Kisozi (Urundi) (W. KUCZAROW). (document roneotyped)

Water Factor.

- L'économie en eau de quelques sols Congolais (CROEGELERT, KUCZAROW, GANEFF). (N° 24)
- Moisture measurements in East African soils (H.C. PEREIRA). (N° 29)
- Discussion.

4.45 p.m.

Tea

FRIDAY, 13th AUGUST, 1954. (continued).

AFTERNOON

5.15 p.m.

Choice of: Visit to the Museum of Prehistory.
or Visit to the Geological Museum (comments
in English)
or Visit to the Geographical Museum of
the Belgian Congo.

8 p.m.

Visit to the Museum of Native Life, or
Cinema show at the "Service de l'Information"
(films taken in the Congo).

Sub-Committee for Classification and Cartography. (Hall D)

2.30-4.45 p.m. Study of various types of African soil.

ARID REGION SOILS

-The soils of the desert and arid regions of
South Africa (C.R. VAN DER MERWE). (N° 63)
-Les sols du secteur cotonnier de Haute-Volta
(NOEL LENEUF). (N° 78)

BLACK SOILS of Mozambique (F.B. RIPADO)

PEAT SOILS of South of Mozambique (F.B. RIPADO)

Les SOLS du Zambèze (H.G. GOUVEIA)

-Pedocals of Mozambique (D.H.G. GOUVEIA -
A.L. AZEVEDO).

4.45 p.m.

Tea.

5.15 p.m.

Choice of: Visit to the Museum of Prehistory
or Visit to the Geological Museum (comments
in English.)
or Visit to the Geographical Museum of the
Belgian Congo.

8 p.m.

Visit to the Museum of Native Life, or
Cinema show at the "Service de l'Information"
(films taken in the Congo).

SATURDAY, 14TH AUGUST, 1954.

10.30 a.m. PLENARY SESSION (Hall J)

Reading and approval of Recommendations and Resolutions of the Conference.

Closing of the Conference.

1 p.m.

Official Luncheon presided over by the Governor General of the Belgian Congo.

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I. DELEGATES

FEDERATION de la RHODÉSIE et du NÉZÉLAND

FEDERATION of RHODESIA and NEZÉLAND

M. J. J. DUVERGNE, Chief Conservation and Extension Officer, Leader of the Delegation.

MERTON,

Dr. CHAVEZ,

Dr. SCHMIDT,

F. D. THOMAS,

S. PARSON, Agricultural Chemist.

JACKSON,

C. C. T. A.
DEUXIEME CONFERENCE INTERAFRICAIN DES SOLS
SECOND INTERAFRICAN SOILS CONFERENCE

LEOPOLDVILLE, 9-14/VIII, 1954

N° 2

LISTE PROVISOIRE DES PARTICIPANTS

PROVISIONAL LIST OF PARTICIPANTS

(Arrêtée au I.VIII.1954)
(As on VIII, 1th 1954)

I. DELEGUES

FEDERATION de la RHODESIE et du NYASSALAND

FEDERATION of RHODESIA and NYA SALAND

MM. J.J. DUVENAGE, Chief Conservation and
Extension Officer, Leader
of the delegation.

MURTON,

Dr CONVERSE,

Dr SAUNDERS,

P.G. THOMAS,

E. PAWSON, Agricultural Chemist.

JACKSON,

- 2 -
P O R T U G A L

MM. J.M. BOTELHO da COSTA, Professeur à l'Institut
Superior de Agronomia,
Chef de la Mission Géolo-
gique de l'Angola,
Chef de la Délégation.

A. FERREIRA da SILVA, Ingénieur agronome,
Direcção Ge ral do Fomento,
Ministerio do Ultramar, Lisboa.

ANGOLA

MM. Guilherme GUERRA, Ingénieur agronome, Directeur
du Service de l'Agriculture.

Ario LOBO de AZEVEDO, Ingénieur agronome,
Chef de la Brigade Pédologique.

MOZAMBIQUE

MM. D. Armando SALBANY, Ingénieur agronome,
Chef du Département de la
Conservation du Sol.

GODINHO GOUVEIA, Ingénieur agronome,
Chef du Service Pédologique
de la Junta do Algodão.

Mario FERNANDES
BENTO RIPADO, Ingénieur agronome au Service
de l'Agriculture.

ROYAUME - UNI

UNITED KINGDOM

MM. Dr. Herbert GREENE, Adviser on Tropical Soils to
the Secretary of State for the
Colonies,
Rothamsted Experimental Station,
Harpenden, Herts,
Leader of the Delegation.

Dr. A. MUIR, Head of the Soil Survey of
England and Wales, Rothamsted.

EAST AFRICA

MM. W.E. CALTON, Government Chemist, Tanganyika.

L.J.S. LITTLEJOHN, Chief Soil Conservation Officer,
Tanganyika.

A. M. SPURR, BSc.
F.G.S. Geologist, Geological Survey,
Tanganyika.

Dr. E.M. CHENERY, Senior Chemist, Uganda.

MM. Dr. H.C. PEREIRA,	Soil Physicist to the East African Agricultural and Forestry Research Organisation.
C. TRAPNELL,	Officer in Charge of the Ecology Training Scheme, attached to the East African Agricultural and Forestry Research Organisation.
E. BELLIS,	Senior Soil Chemist, Department of Agriculture, Kenya.

WEST AFRICA

MM. Dr. H. VINE,	Senior Chemist and Soil Scientist, Nigeria.
Dr. C.F. CHARTER, O.B.E.,	Director of the Soil and Land Use Survey in the Gold Coast.
H. BRAMMER,	Soil Survey Officer in the Gold Coast.
Dr. S.N. ADAMS,	Soil Chemist, West African Cocoa Research Institute.
Dr. R.A. WEBB,	Soil Scientist in the Gambia.

BASUTOLAND

M. A.C. VENN,	Soil Fertility Officer, British High Commission Territories in S. Africa.
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UNION DE L'AFRIQUE DU SUD

UNION of SOUTH AFRICA

MM. Dr. P.P. HENNING,	Director of Soil Conservation and Extension, <u>Leader of the Delegation.</u>
(*) Dr. J.C. ROSS,	Division of Soil Conservation and Extension, Secretary General of SARCCUS.
Dr. J. VAN GARDEREN,	Division of Chemical Services.
Dr. C.R. VAN der MERWE,	Division of Chemical Services.
J.S. BARNARD,	Vice-Consul, South-African General Consulate, Léopoldville, Secretary of the Delegation.

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UNION FRANCAISE

- MM. GAZONNAUD, Inspecteur Général des Eaux et Forêts
en A.E.F.
Chef de la Délégation.
- ANGLADETTE, Ingénieur en Chef de l'Agriculture
d'Outre-Mer,
Directeur de la Section Technique
d'Agriculture Tropicale (O.R.S.T.O.M.)
- AUBERT, G. Professeur de Pédologie à l'O.R.S.T.O.M.

A. O. F.

- MM. (x) M. GAUDY, Secrétaire permanent et Président du
Comité de l'Ouest Africain des Sols,
Ingénieur en Chef des Services de
l'Agriculture.
- P. BELLOUARD, Conservateur des Eaux et Forêts,
Chef de la Section Technique de
l'Inspection Générale des Eaux et
Forêts.
- J. BOUYER, Maître de recherches des laboratoires
de l'Agriculture d'Outre-Mer, Chef
de la Division de Chimie du C.R.A. de
BAMBEY.
- H. MOULINIER, Maître de recherches des laboratoires
de l'Agriculture d'Outre-Mer, Chef du
laboratoire des Sols du C.R.A. de
Bingerville.
- VEROT, Chef de Travaux des laboratoires de
l'Agriculture d'Outre-Mer, Centre de
recherches rizicoles de Kankan.
- MAIGNIEN, Chef du Centre Pédologique de Hann.
- LENEUF, Chef du Laboratoire de Pédologie de
l'I.D.E.R.T. à Adiopodoumé.
- M. LAMOUROUX, Pédologue de l'Institut de recherches
scientifiques au Togo.

A. E. F.

- MM. COIENO, Inspecteur Général de l'Agriculture de
l'A.E.F.
- (x) GUILLEMIN, Ingénieur agronome, Secrétaire permanent
du Bureau des Sols d'A.E.F.
- J.L. BUSCH, Ingénieur agronome, Chef de Travaux
de 1ère classe des Services de
l'Agriculture.
- J.M. BOYER, Ingénieur agronome, Chef de Travaux
des Services de l'Agriculture.
- J.M. BRUGIERE, Maître de Recherches à l'Institut
d'Etudes Centre-africaines.

CAMEROUN

- MM. J. GUILLARD, Inspecteur des Eaux et Forêts,
Chef de l'Inspection Forestière
du Nord Cameroun.
- A. LAPLANTE, Maître de Recherches à l'O.R.S.T.O.M.
Chef de la Section de Pédologie à
l'I.R.C.A.M.
- E. de LAPERSONNE, Maître de Recherches de 1ère classe
des Laboratoires, Pédologue et
Chimiste du Sol du Service de l'Agricul-
ture du Cameroun.

MADAGASCAR

- MM. Y. DOMMERGUES, Ingénieur agronome, Inspecteur
principal des Eaux et Forêts.
- J. RIQUIER, Ingénieur agricole, Maître de
Recherches de l'I.R.S.M.,
Secrétaire-Adjoint du Bureau des Sols.
- P. ROCHE, Ingénieur agronome, Ingénieur des
Services de l'Agriculture, Chef de la
Division du Milieu à la Station Agro-
nomique du Lac Alaotra.

B E L G I Q U E

- MM. J. HENRARD, Ingénieur agronome, Directeur de
l'Agriculture du Ministère des
Colonies, Chef de la Délégation.

SERVICE DE L'AGRICULTURE

- MM. G. DUBOIS, Ingénieur agronome, Directeur Général
de l'Agriculture au Congo Belge.
- D. MICHOTTE, Ingénieur agronome, Directeur a.i.
du Service de l'Agriculture.
- J. COLLEAUX, Ingénieur agronome forestier.
- A. DECRAENE, Ingénieur agronome.
- M.G. KEVERS, Ingénieur agronome.
- E. BECKMANN, Ingénieur agronome hydraulicien.
- J. COURCELLES, Ingénieur agronome.
- J. DEHEYN, Agronome.
- F. CORIN, Ingénieur géologue.

I N E A C

MM.	F. JURION,	Directeur Général de l'INEAC.
	J. LEBRUN,	Secrétaire Général.
	M. LECOMTE,	Directeur Général en Afrique.
	J. HENRY,	Directeur du Centre de Recherches de Yangambi.
	E. BERNARD,	Maître de Recherches.
	R. PICHEL,	Maître de Recherches.
	A. FOCAN,	Directeur Régional.
	H. LAUDELOUT,	Maître de Recherches.
	A. MOLLE,	Directeur du Bureau des Congrès.
	J. CROEGAERT,	Chef de Laboratoire.

II. REPRESENTANTS DES ORGANISMES DE LA C.C.T.A.

REPRESENTATIVES OF THE C.C.T.A. ORGANIZATIONS.

SECRETARIAT DE LA C.C.T.A.

SECRETARIAT OF C.C.T.A.

M. J.W.M. TURNER,

Secrétaire Général Adjoint.
Assistant Secretary General.

B. I. S.

M.J. GUILLOTEAU,

Directeur de Bureau Interafricain
des Sols et de l'Economie Rurale.
Director of the Interafrican
Bureau for Soils and Rural Economy.

S. P. I.

M.J. D'HOORE,

Directeur du Service Pédologique
Interafricain.
Director of the Interafrican
Pedological Service.

C. S. A.

M.G. AUBERT,

Membre du Conseil Scientifique
pour l'Afrique au Sud du Sahara.
Member of the Scientific
Council for Africa South of the
Sahara.

COMITES REGIONAUX POUR LA CONSER-

VATION ET L'UTILISATION DU SOL.

REGIONAL COMMITTEES FOR SOIL
CONSERVATION AND UTILISATION.

Comité Régional de l'Afrique Méridionale pour la Conservation et l'Utilisation des Sols.

South African Regional Committee for Soil Conservation and Utilisation (SARCCUS).

Dr. J.C. ROSS

Secrétaire Général.
General Secretary.

Comité Régional de l'Afrique Centrale pour la Conservation et l'Utilisation des Sols.

Central African Committee for Soil Conservation and Utilisation (CRACCUS)

M. GUILLEMIN,

Secrétaire du Bureau des Sols de l'A. E. F.
Secretary of the Soils Bureau of A. E. F.

Comité Régional de l'Afrique Occi-
dentale pour la Conservation et
l'Utilisation des Sols.

West African Regional Committee for
Soils Conservation and Utilisation

M. GAUDY,

Président et Secrétaire permanent
du Comité.

Chairman and permanent Secretary
of the Committee.

x

x

x

III. OBSERVATEURS.

OBSERVERS

ALGERIE

ALGERIA

M. J.H. DURAND,

Chef de la Section de Pédologie du
Service des Recherches Scientifiques
Alger.

AUSTRALIE

AUSTRALIA

M. G. STEWART,

Senior Survey **Officer**, Canberra.

ETAT-UNIS D' AMERIQUE

UNITED STATES OF AMERICA

M. Dr C. KELLOGG

Assistant-Administrator for Soil
Survey, Soil Conservation Service
USDA.

O. A. A.

F. A. O.

M. Dr IGNATIEFF,

Soil Specialist, Division of
Agriculture, United Nations Food
and Agriculture Organisation.

PAYS - BAS

NETHERLANDS.

M. Prof. Dr F.A. VAN BAREN, Institut Royal des Régions
tropicales, Amsterdam.

SOUDAN

SUDAN.

M. Dr. JEWITT,

Research Division, Ministry of
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COMITE SPECIAL DU KATANGA

M. G. DUBOIS, Directeur du Service des Mines.

COMITE NATIONAL DU KIVU

M. J. THIRION, Chef du Service Pédologique.

EMPIRE COTTON GROWING CORPORATION

M; P. H. LE MARE

IV. INTERPRETES ET TRADUCTEURS

MM. F; BARKER, Conseiller linguistique de la
C.C.T.A.

J. HAUPT,

Mlle. M. C. GASTUCHE

M. V. H. JALHAY

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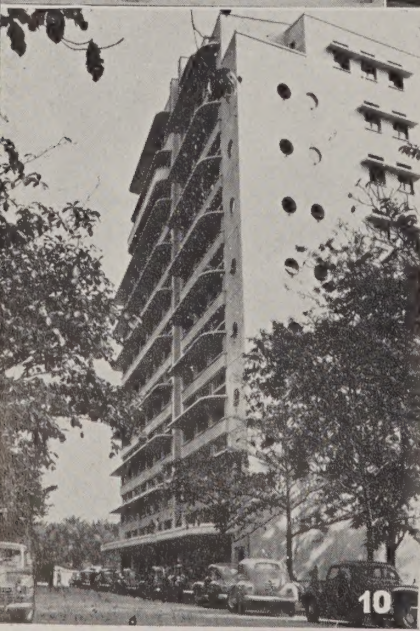
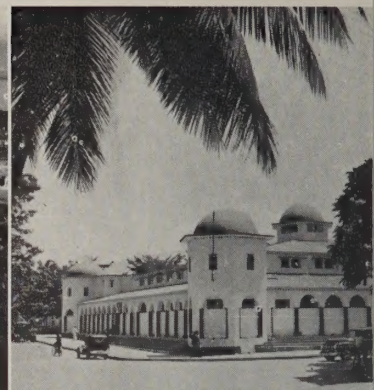
LEOPOLDVILLE

AOÛT 1954



CONGO BELGE

— CONFÉRENCE INTERAFRICAINES DES SOLS —
5^{me} CONGRÈS INTERNATIONAL DE LA SCIENCE DES SOLS



Quelques aspects de la ville de Léopoldville

A few scenes of the town of Léopoldville

- 1) Building Administratif.
Administrative building.
- 2) Le monument Albert, la gare, le port.
The Albert monument, the station, the port.
- 3) L'ancien marché indigène.
The old native market.
- 4) La gare — *The station.*
- 5) Le Port Public — *The public Port.*
- 6) L'Avenue Prince Baudouin.
Prince Baudouin avenue.
- 7) Un bureau de la Caisse d'Epargne.
A branch of the Savings Bank.
- 8) La salle des guichets de la poste centrale.
Pay-desk office of the Central Post Office.
- 9) Le Stade Baudouin. — *The Baudouin stadium.*
- 10) Building Forescom. — *Forescom Building.*



Présentation de Léopoldville



Cette ville où vous ont appelé les graves assises d'un congrès scientifique mérite autre chose qu'un coup d'œil distrait ou désabusé.

Sans doute, les grands itinéraires touristiques et les poètes l'ignorent toujours. Naguère encore ses habitants s'en seraient glorifiés. Les bâtisseurs d'empire se méfient des esthètes. Il en est peut-être même parmi leurs successeurs qui admettent difficilement que des soucis moins exclusivement pratiques préoccupent déjà les maîtres de l'heure et nombre de leurs concitoyens.

Ces préoccupations esthétiques témoignent, entre autres, du souci de transformer le comptoir d'antan en Cité. Elles tiennent compte des exigences d'un avenir prévisible au moins autant que des nécessités de l'heure.

Léopoldville n'a pas soixante-quinze ans. Pour un centre urbain, c'est l'extrême jeunesse, sinon l'enfance. En 1882 elle rassemblait, en une plateforme aménagée sur le versant sud-est du Mont Léopold les magasins et les logements de Stanley et de ses compagnons. Le choix de l'emplacement, le prodigieux essor et l'expansion ultérieure de la ville étaient inscrits dans la géographie. L'immense bief navigable du Congo supérieur et de ses grands affluents s'arrête au seuil des Monts de Cristal dès la sortie du Stanley Pool. C'est donc là que devait surgir le premier port fluvial de l'Afrique centrale. C'est là aussi que se situerait la tête de ligne du chemin de fer qui, par Matadi, relierait le Haut Congo à l'Océan et au monde occidental.



Léopoldville s'est fortement étendue et développée depuis quelques années. Ces deux photos prises du même endroit datent de 1945 et 1954.

Leopoldville has spread out very much in recent years. These two snapshots are taken from the same place one in 1945 and the other in 1954.



Cette double qualité justifierait, plus tard, l'élévation de Léopoldville au rang de capitale.

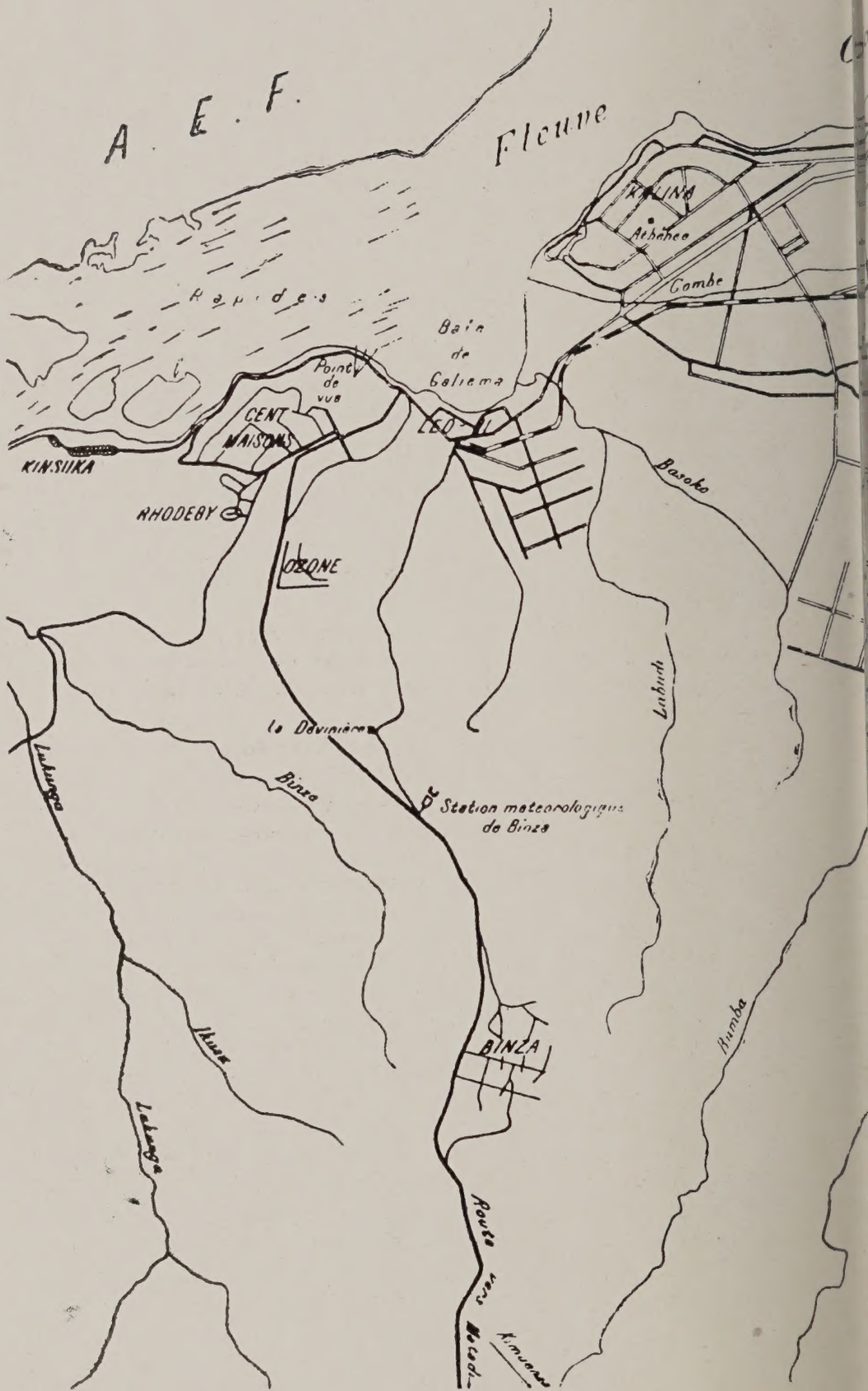
La ville porte le nom du deuxième roi des Belges, fondateur et souverain d'un état dont il devait confier la gestion à ses sujets européens après en avoir assuré politiquement, militairement et économiquement, la viabilité.

Trois cent mille habitants, dont 16.000 Blancs, parmi lesquels 80 % de Belges, 10 % de Portugais et 10 % d'Européens et d'Américains de nationalités diverses. Un port où l'on manipule plus d'un million de tonnes par an. Un centre commercial (Kinshassa), qui fut d'abord un comptoir isolé. Un centre administratif (Kalina). De nombreux quartiers résidentiels européens répartis le long du fleuve et dans les collines qui bornent, à l'ouest, la plaine alluvionnaire. Plusieurs cités indigènes tentaculaires s'étendant en une ceinture continue au sud des quartiers européens et en limitant l'extension en surface, ce qui détermine, entre autres, le recours à la construction en hauteur. Plusieurs zones industrielles. Des cités indigènes satellites et un aéroport de classe internationale. Tout cela, réparti sur une superficie équivalente à celle du Grand Bruxelles.

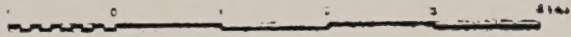
Certaines promenades et certaines visites vous aideront à deviner la structure et à découvrir les composantes de la capitale du Congo Belge, à en évoquer le passé, à en pressentir l'avenir, à en percevoir le charme.

On vous mènera au sommet du mont Léopold par une avenue du Roi Souverain dont les vétustes constructions, ombragées d'arbres séculaires ont un caractère de vieille province endormie dans ses jardins. Au-delà de ces pelouses, à main droite, et à flanc de coteau, Stanley édifia le premier poste européen. Quelque très ancien résident, quelque curieux d'histoire locale, identifiera, à votre intention, des vestiges perdus dans les herbes. Le cimetière des pionniers est à deux pas. Ceux qui sont morts à la tâche, à l'époque héroïque, en ce coin du monde aujourd'hui si hospitalier ont bien mérité la pensée que vous accorderez peut-être à leur mémoire, dans l'enclos campagnard qui recèle leurs tombes. Cette visite et le recueillement spéculatif qu'elle implique pourraient vous faire mieux apprécier, les mérites des hommes qui ont permis que se déploie, en un immense panorama, la ville énorme dont votre cicerone vous indiquera au loin les points de repère. La ville, le Pool, les monts, le cirque de collines qui enserrant l'énorme étalement du fleuve aux bords duquel croissent et embellissent les deux capitales sœurs de l'Afrique centrale : Brazza la Française, Léo la Belge.

C'est en navigant de l'une à l'autre sur une de ces vedettes à moteur qui partent du « beach » proche du « Palace » toutes les demi heures que vous découvrirez un deuxième aspect de Léopoldville. Murs de quai, entrepôts, grues innombrables, silos, réservoirs, allèges,



LEOPOLDVILLE ET ENVIRONS



bateaux courriers ou grands remorqueurs révèlent ici, dans toute son ampleur la vocation portuaire de la cité. Sur des kilomètres, la rive du fleuve est vouée au trafic efficient du matériel moderne.

Lancez-vous à présent sur la route qui, au débouché du plateau de Léo II s'enfonce dans un bois. Dépassez le quartier résidentiel de l'Ozone. Par monts et par vaux, à travers une banlieue agreste, mettez le cap sur Kasangulu ? Vous abandonnerez bientôt l'asphalte pour une piste de sable qui vous mènera sur les hauteurs proches de Lovanium, centre préuniversitaire où s'ébauche une expérience d'enseignement supérieur pour Congolais. Par delà la dernière chaîne de collines qui vous sépare de la plaine où la ville essaime quartiers neufs et cités satellites, vous découvrirez au loin le troisième aspect de la capitale congolaise — une ville industrielle en prodigieux développement. Vous la traverserez en regagnant votre hôtel. Une nouvelle plongée dans la fraîcheur d'un bois ; la plaine ; l'autoroute de Kenge.

A droite, un double ruban asphalté vous offre une rapide et confortable incursion dans la savane brûlée, vers un horizon de collines dominé par la silhouette du « Pic Mense » et la surprenante révélation de la piste géante du nouvel aéroport. A gauche, c'est le chemin du retour.

Le jeune et blanc visage de la banlieue industrielle (Limete) vous sera progressivement révélé, complétant et détaillant la vision d'ensemble de tout à l'heure.

Cette ville qui vous a livré le secret de son prodigieux essor il vous faut maintenant la découvrir de l'intérieur. L'ampleur de cette entreprise sera fonction du temps dont vous disposerez. Nous nous bornerons donc ici à quelques suggestions.

L'Avenue Prince Baudouin, étroite, populeuse, bordée de bārs traverse de part en part l'ancienne Cité Indigène de Léo-Est. Elle est enfouie dans une palmeraie, comme une oasis. Vous roulez très lentement. Si le charme opère, vous descendrez de voiture et vous vous engagerez, à pied, dans les avenues latérales...

Au-delà des vieux quartiers, c'est, provisoirement le foisonnement géométrique des cités champignons. Grandes artères de sable pulvérisent assommées de soleil et aux maigres abrisseaux. L'humanité qui s'y agite vous rendra votre sourire pourvu qu'il ne soit ni condescendant ni moqueur.

Entre le port de Kin et les chantiers navals de la Chanic, la rive du fleuve, plus escarpée, est accessible au promeneur. Les coins charmants et pittoresques abondent : derrière la BMS, au-delà du consulat de France, à côté des jardins de la Résidence, à la Raquette, à l'embouchure de la Gombe et dans le quartier bucolique de Léo II où subsistent des maisons préfabriquées d'il y a soixante ans.



La Poste Centrale. — *Central Post-Office.*

La Banque du Congo Belge.



Au-delà, il y a les cocotiers de l'Avenue Mahieu et la route en basse corniche qui mène à l'île des Mimosas, au village et aux rapides de Kinsuka. Le lit même du grand fleuve et ses abords immédiats constituent ici l'inépuisable carrière des constructeurs de Léo.

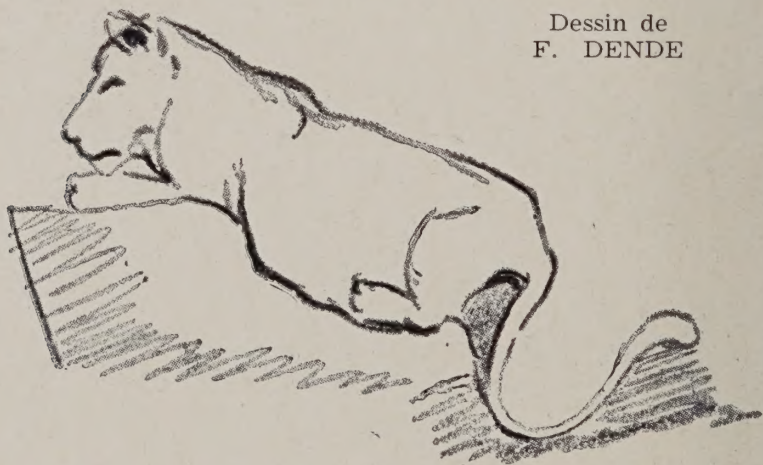
La promenade de la grande corniche domine de très haut l'énorme étendue des îles, des amoncellements rocheux et des rapides où le fleuve se rue à la sortie du Pool. C'est de là ou du « point de val », proche de la clinique Reine Elisabeth, qui domine la baie de N'Galiéma, qu'il faut voir le soleil descendre sur les monts de Cristal et incendier un panorama inoubliable.

Vous pouvez, à la rigueur, consacrer quelques minutes au parc de Bock et au Zoo, mais il faut voir cette arène aux proportions, inattendues si près de l'équateur africain : le Stade Baudouin. Dans le même ordre d'idées voyez l'Athénée Royal, le lycée du Sacré-Cœur et le bâtiment où le Gouvernement Général concentre ses services. Allez méditer au besoin devant les plus jeunes ruines de la ville : les tribunes d'un hippodrome construit il y a vingt-cinq ans et supprimé par un quartier neuf dont la Société d'encouragement de l'époque n'aurait pu envisager la nécessité.

Une visite au Musée de la Vie Indigène de Léo constituera enfin une valable initiation au folklore congolais, par la valeur intrinsèque des collections comme par la sélection artistique et pédagogique qui ont présidé aux choix des objets exposés.

Vous trouverez ailleurs le curriculum vitae, le bulletin de santé, la description et le portrait de notre bonne ville de Léo. Notre propos n'était que de vous la présenter. Nous espérons que vous deviendrez de bons amis.

René POELMANS.



INTRODUCTION TO LEOPOLDVILLE

This city, where the solemn meetings of a Scientific Congress are taking place, deserves something more than a casual or indifferent glance. It is no doubt, still unknown to big tourist guides and poets. Not so long ago, its inhabitants would have boasted about it; Empire builders distrust aesthetes. And even some of their successors do not admit readily that less exclusively practical worries already occupy the minds of the present leaders and many of their fellow citizens.

These aesthetical preoccupations testify amongst other things, their endeavour to transform the trading post of bygone days into a City. They take into account the demands of an anticipated future as much as the necessities of the present time.

Leopoldville is not yet 75 years old. For a town it is in its extreme youth, practically in its infancy. In 1882, on the south-eastern slope of Mount Leopold, were assembled the shops and lodgings of Stanley and his companions. The choice of the site and the subsequent expansion of the town were dictated by geography. The immense navigable reaches of the Upper Congo River and its large tributaries end at the foot of the Cristal Mountains, at the outlet of the Stanley Pool. Thus, it was there that the most important river port of Central Africa was to rise. It was there also that the head of the railway line was to be located, and, through Matadi, was to connect the Upper Congo with the Atlantic Ocean and the Western world. This double advantage was to help elevate Leopoldville to the rank of Capital later on.

The town was named after the second King of the Belgians, who was the founder and sovereign of a country, the administration of which he entrusted to his European subjects after having assured its viability politically, militarily and economically.

There are 300,000 inhabitants of which there are 16,000 whites, amongst which 80 % are Belgians, 10 % Portuguese and 10 % Americans and Europeans of various nationalities. The port handles more than a million tons per year. The Commercial Centre of Kinshasa was at first an isolated trading post. The Administrative centre is in Kalina. There are numerous European residential quarters spread along the river front and in the hills which border the alluvial plain to the west. A number of native towns extend in a continuous belt from the south of the European quarters, limiting their expansion in surface, which necessitates elevation in construction. There are a number of Industrial zones, secondary native villages and an airport of International standard. All this is spread over a surface equivalent to that of Brussels, including its suburbs.

Some strolls and visits will help you to form an idea of the structure and to discover the salient characteristics of the Capital of the Belgian Congo, and to recall its past, foresee its future and appreciate its charm.

You can go to the summit of Mount Leopold by way of the Avenue du Roi Souverain, which, with its ancient constructions, shadowed by century-old trees, gives you the impression of an old province asleep in its gardens. Beyond the lawns, to the right and by the road that follows the hillside, Stanley set up the first European trading post. A very old resident or someone interested in local history could still identify for you the traces lost in the grass. Nearby can be found the pioneer cemetery. Those who died at their task in that heroic age, in this part of the world, which is so hospitable today, well deserve any thought you may give to their memory in this corner of the countryside which holds their graves. This visit and the contemplation it evokes, can help you to appreciate better the worth of the men who have contributed to the expansion of this big town, the landmarks of which will be pointed out by your guide. (The town, the Stanley Pool, the mountains, and the amphitheatre of hills which hems in the enormous stretch of the Congo river, on the banks of which rise the two sister capitals of Central Africa: Brazzaville of French Equatorial Africa and Leopoldville of the Belgian Congo.)

By crossing from one side of the Congo River to the other, on motor boats which leave the Beach near the Palace Hotel every half hour, you discover another aspect of Leopoldville. Quay-side, warehouses, innumerable cranes, store-pits, fuel tanks, barges, river steamers and large tow-boats show in full the importance of the town as a port. For many kilometers along the banks of the river the port is busily engaged with the gigantic traffic of modern machinery.

Now you take the road at the opening of the Leo II plateau, which runs into a wood, and pass by the residential quarters of the Ozone. Over hill and dale, through a rustic suburb, you head for Kasangulu. Soon you will leave the asphalt for a track of sand which will lead you to the nearby heights of Lovanium, the pre-University centre where a higher education experiment programme is outlined for the Congolese. Beyond the last chain of hills which separate you from the open country, where the town swarms with new quarters and secondary villages, you will discover, in the distance, the third aspect of the Capital of the Congo: an industrial town in mushroom development. (You will pass through it on your way back to the hotel). Continuing your journey you pass into the coolness of a wood and out into the open country, to the Kenge highway. To the right, a double ribbon of asphalt offers you a rapid and comfortable approach to the sun-scorched savannah stretches, and of a horizon of hills dominated by the silhouette of the Mense-Peak, and then you arrive at the new airport with its giant tarmac.

The young and white façade of the industrial suburb of Limete will be revealed to you progressively, showing in detail the view you previously had as a whole.

Let us now explore from the interior, this city of Leopoldville, which has so far revealed to you the secret of its stupendous growth. This is rather a large undertaking and will use up much of your spare time. Here are some suggestions that might prove helpful :

The Prince Baudouin Avenue, narrow, densely populated and bordered with bars, passes through the old Native township of Leo I. It runs through a palm-grove resembling an oasis. Drive slowly, and we hope you will find this enchanting enough to tempt you to leave your car and walk down the side-streets. Beyond the old quarters is the temporary geometrical expansion of mushroom villages. You go along sandy tracks, sun baked, with meagre scrub. Passers-by will return your smile as long as it is neither condescending nor mocking.

Between the Port of Kin and the Chanic Naval dockyards, you can stroll along the steeper banks of the Congo river, which abound in charming and picturesque corners. (Behind the BMS, beyond the French Consulate, near the gardens of the Governor General's Residence ; at the « Raquette », and at the mouth of the Gombe River and in the bucolic quarters of Leo II, where prefabricated houses of sixty years ago are to be found. Beyond grow the coconut palms of the Avenue Mahieu, and from here the road runs along the river front leading to the Isle of the Mimosas, and then to the Native village and the rapids of Kinsuka. The bed of the great river and its near approaches here contain an inexhaustible rock-quarry for builders in Leopoldville.)

The « Grande Corniche » dominates the vast stretches of islands, the rocky formations and the rapids where the river hurls along at the outlet of the Pool. It is from there, or from the site near the Queen Elisabeth Clinic, which dominates N'Galiema Bay, that you should watch the setting sun over the Cristal Mountains as it lights up an unforgettable panorama.

If necessary, a few minutes could be devoted to the Parc de Bock and the Zoo, but what you must see is the Baudouin Stadium, the proportions of which are so unexpected in a place so near the African Equator. Also worth a visit is the Royal Athenaeum, the Lyceum of the Sacred Heart and the Government Administrative Buildings. You could also pay a visit to the town's most recent ruins : — the Hippodrome, which was built 25 years ago and which has given way to a new residential quarter.

Lastly, a visit to the Leopoldville Museum of Native Art will give you a good idea of Congolese folklore, both by its intrinsic value and by the artistic and pedagogic selection of the objects exhibited.

You will find elsewhere the curriculum vitae, health bulletins, and the description and portrait of our good town of Leopoldville. Our purpose was only to introduce it to you. We hope that you will become good friends.

René POELMANS.



Théâtre de Verdure — *Open Air Theater*

LABORATOIRE DES TRAVAUX PUBLICS

Le Laboratoire des Travaux Publics du Gouvernement Général (33, avenue Valcke, Léopoldville, téléphone 3402) effectue les essais les plus divers sur les sols et les matériaux de construction.

Les sols sont au Congo des matériaux très importants pour la construction des routes et des aérodromes. Les stabilisations de sols sont basées sur des procédés mécaniques (compaction) et chimiques : incorporation de liants hydrauliques ou bitumineux, ou de produits hydrofuges, ou de bases remplaçantes.

Une carte des sols congolais d'après leurs propriétés mécaniques est en voie d'élaboration.

Parmi les autres matériaux étudiés au Laboratoire des Travaux Publics, les pierres naturelles, les ciments, les bétons, les bitumes, et les agglomérés divers sont les plus importants.

— La visite de ce laboratoire sera organisée les 11 et 18 août à 17 heures.

PUBLIC WORKS LABORATORY

The « Laboratoire des Travaux Publics » of the Government General (33, avenue Valcke, Leopoldville, telephone 3402) is a research and testing laboratory for soils and building materials.

Soils are important materials for highway and airport construction in the Congo. Soil stabilization processes are either mechanical (compaction) or chemical: admixture of hydraulic or bituminous binders; or waterproofing agents, or non soluble bases.

A map of Congo soils with respect to their engineering properties is being prepared.

Other materials under frequent investigation at the Laboratoire des Travaux Publics are natural stones, cements, concretes, bitumens and various bricks.

— A visit to this Laboratory will be organised on the 11th and 18th August, at 5 o'clock.



MUSEE DE LA VIE INDIGENE

Le Musée de la Vie Indigène, place de la Poste à Léopoldville, réunit une collection d'environ 6.000 objets appartenant à l'art et au folklore congolais. Le visiteur pourra y découvrir les différents aspects de la culture congolaise. Les collections sont groupées dans deux salles dont l'une répond à une classification ethnique; l'autre à une classification idéologique.

Le Musée est accessible au public tous les jours, y compris le dimanche, de 9 h. à 12 h. et de 15 h. à 17 h. 30.

— Ce musée sera accessible au public les mardi et vendredi soir.
Visite guidée à 20 h. 30.

MUSEUM OF NATIVE LIFE

The Museum of Native Life, Place de la Poste, Leopoldville, has a collection of about 6.000 objects appertaining to Congolese art and folklore. The visitor can discover different aspects of Congolese culture. The collections are grouped in two large rooms, one of which can be classed as having an ethnical classification, and the other an ideological classification.

The Museum is open to the public every day except Sunday from 9 a.m. — noon, and from 3 p.m. — 5.30 p.m.

— This Museum will be open to the public on Tuesday and Friday evenings.
Guided visit at 8.30 p.m.

L'INSTITUT GEOGRAPHIQUE DU CONGO BELGE

A été créé le 1^{er} janvier 1950 sous la forme d'une administration personnalisée, soumise à l'autorité du Gouverneur Général du Congo Belge.

Il est chargé d'exécuter, pour le compte des services officiels ou d'organismes privés, des travaux de géodésie, topographie et cartographie au Congo Belge et au Ruanda-Urundi, d'élaborer et de publier la carte de ces territoires africains.

Depuis sa création, il a établi des documents cartographiques — le plus souvent uniquement planimétriques et aux petites échelles — intéressant quelque 400.000 km² dans les régions à grande expansion économique.

Utilisant au maximum les procédés photogrammétriques, il a été conduit à procéder à des prises de vues aéro-photographiques couvrant plus de 450.000 km² à ce jour. La progression annuelle escomptée est voisine de 180.000 km².

L'échelle de ces prises de vues est généralement proche du 1/40.000 laquelle permet l'exploitation cartographique la plus économique pour les vastes régions à traiter.

L'emploi de films infra-rouges a été généralisé pour retirer le profit maximum de conditions atmosphériques si fréquemment défavorables à la photographie aérienne en région équatoriale.

Aussi rapidement que possible, des assemblages photographiques sont réalisés à l'aide des épreuves et mis à l'échelle du 1/50.000 (par planches d'environ 1.000 km²).

Ces documents photographiques constituent un moyen d'études et un guide précieux dans tous les domaines en rapport avec la géographie physique et économique.

Tout comme les documents cartographiques, ils peuvent être consultés et acquis dans les locaux de l'Institut Géographique du Congo Belge, Boulevard Albert I^{er}.

- La visite de cet Institut sera organisé les 13 et 17 août à 17 heures.
- *A visit to this Institute will be organised on the 13th and 17th August, at 5 o'clock.*



The Belgian Congo Geographical Institute was created on January 1, 1950, in the form of a private government service subjected to the authority of the Governor General of the Belgian Congo.

It executes surveys, the topography and cartography of the Belgian Congo and Ruanda-Urundi, and draws up and prints maps of these African territories for official services or private organizations.

Since its creation, it has established cartographic documents — more often than not uniquely planimetric and on small scale — for some 400.000 square kilometres in regions with great economic expansion.

Utilizing photogrametric processes to a maximum, up to the present time it has made aerial photographs covering more than 450.000 square kilometres. The anticipated annual progression is in the neighbourhood of 180.000 square kilometres.

The scale of these photographs is generally around 1/40.000 which offers the most economic cartographic working method for the vast regions to be dealt with.

The use of infra-red films has been generalized so as to derive the maximum profit from atmospheric conditions so frequently unfavourable to aerial photography in equatorial regions.

As fast as possible, photographic assembling is realized with the help of proofs, and made to a scale of 1/50.000 (by plates of around 1.000 square kilometres).

These photographic documents constitute a means of study and a precious guide in all fields as regards physical and economic geography.

Just as for cartographic documents, they can be consulted and acquired at the Belgian Congo Geographical Institute, Boulevard Albert I^{er}.



MUSEE DE GEOLOGIE — GEOLOGICAL MUSEUM

- Une excursion avec commentaires en français sera organisée les 10 et 18 août à 17 heures.

La même excursion avec commentaires en anglais sera organisée les 13 et 20 août à 17 heures.

- An excursion, commentated in French, will be organised on the 10th and 18th of August, at 5 o'clock.

The same excursion, commentated in English, will be organised on the 13th and 20th of August, at 5 o'clock.



ZOO ET JARDIN BOTANIQUE

La Société de Botanique et de Zoologie Congolaises qui a été fondée en 1936 et qui prenait alors la succession de l'Association des Amis du Parc, gère le jardin zoologique de Léopoldville et favorise l'aménagement et l'embellissement du Parc Fernand De Bock qui constitue en fait un véritable jardin botanique en égard au grand nombre de variétés différents de plantes tropicales qu'il contient.

Le jardin zoologique s'est fixé pour but de réunir les principales espèces courantes du centre africain. Seuls, deux animaux non africains figurent dans sa collection : un ours et un tapir, et ce, parce qu'ils ont été offerts au zoo en échange d'animaux congolais.

L'accès du zoo et du jardin botanique est libre et rencontre une grande faveur auprès du public de la capitale.

Un bar-restaurant-tea room est installé dans le jardin zoologique.

Le vaste bâtiment en construction situé en bordure de l'Avenue Prince Baudouin est destiné à abriter les services administratifs et scientifique de la Société de Botanique et de Zoologie Congolaises ainsi qu'une salle de conférence, un aquarium, un vivarium et une bibliothèque.

— Des visites du Zoo seront organisées les 11 et 18 août à 17 heures.

ZOO AND BOTANICAL GARDEN

The Congolese Zoological and Botanical Society was founded in 1936 in succession to the Park Friends Society. It now manages the Leopoldville Zoological garden and helps with the arrangement and improvement of the Fernand De Bock Park, which is in fact a real botanical garden, containing a great number of different species of tropical plants.

The zoological garden's aim is to gather together all the principal species of Central Africa. Only two non-African animals are included in its collection : a bear and a tapir, and that, because they have been given to the Zoo in exchange for Congolese animals.

Access to the Zoo and to the botanical garden is free. It has great success amongst the public of the capital.

There is a bar-restaurant-tea room in the zoological garden.

The big building which is in course of construction near the curb of avenue Prince Baudouin, is to shelter all the administrative and scientific services of the Congolese Botanical and Zoological Society, as well as a conference room, an aquarium, a vivarium and a library.

— Visits to the Zoo will be organised on the 11th and 18th of August, at 5 o'clock.

Okapi au jardin zoologique de Léopoldville.

Okapi in the zoological garden in Leopoldville.

MUSEE DE PREHISTOIRE

Collection d'objets préhistoriques — pierres taillées, poteries anciennes — en provenance de la Plaine de Léopoldville.

La collection fut réunie par le Fr. H. van Moorsel, des Missions de Scheut, et constitue le fruit de ses recherches et fouilles archéologiques.

Ces recherches qui furent commencées en 1932, se sont poursuivies jusqu'à l'heure actuelle. Elles embrassent toute l'étendue de la Plaine de Léopoldville.

La collection se trouve intégrée dans le complexe des installations de l'Institut d'Education Physique (Stade Roi Baudouin).

— Des visites de ce musée seront organisées les 13, 17 et 18 août à 17 heures.

PREHISTORIC MUSEUM

A collection of prehistoric objects — cut stones, old pottery — originating from the Leopoldville Plain.

This collection was gathered by Brother H. van Moorsel, of the Scheut Mission, during his archeological excavations.

These excavations commenced in 1932 — they are continuing up to the present time. They are spread out over the whole Leopoldville Plain.

The collection is housed in the Physical Education Institute (Stade Roi Baudouin).

— Visits to this Museum will be organised on the 13th, 17th and 18th August, at 5 o'clock.

TAXIS

Garage Martins , Avenue des Bakongo	Tél. 27.82
Garage Hardy , Av. Rubbens	Tél. 22.22
Station de Service , Corner Avenue Engels et Fleuve	Tél. 26.66
Garage Kinois , Avenue Tombeur 29	Tél. 33.55
Garage Taxis Vert , Boulevard Albert	Tél. 24.99
Garage du Pool , 6, Avenue Van Gèle	Tél. 25.25

TARIFS

Prise en charge — <i>Hire (en ville - in town)</i>	15 frs
1/4 d'heure — <i>Quarter hour</i> id.	20 frs
1/2 heure — <i>half an hour</i> id.	65 frs
1 h. — <i>one hour</i> id.	105 frs
1 h. 30 — <i>one hour 1/2</i> id.	145 frs
2 h. — <i>Two hours</i> id.	185 frs
Léo II (simple course sans stationn. - <i>single trip without stop</i>)	65 frs
Rhodeby id. id.	100 frs
Devinière id. id.	120 frs
Funa Club (swim) id. id.	45 frs
Limete id. id.	140 frs
Auberge des deux Ponts id. id.	230 frs
Nouvelle Plaine id. id.	300 frs
Djelo Binza id. id.	180 frs
Limete-Djili (aller et retour - <i>return</i>)	230 frs

AUTOBUS POUR LES VISITES ET EXCURSIONS BUS SERVICE FOR VISITS AND EXCURSIONS

Un autobus spécial conduira les participants aux différentes visites organisées à leur intention.

Le départ se fera de l'Athénée à 17 heures.

Au retour l'autobus effectuera le circuit passant par les différents hôtels de la ville et rentrera à l'Athénée.

A special bus will convey the participants to the different visits organised for them.

Departure from the Athenaeum will be at 5 o'clock.

On the way back the bus will pass by the different Hotels of the Town and will then return to the Athenaeum.

L'accès de ces différents autobus est gratuit pour les congressistes et les membres de leur famille.

No fare will be charged on the buses for Congress Members and their families.

SERVICE D'AUTOBUS LOCAUX CONGRES-VILLE BUS SERVICE FROM CONGRESS HEADQUARTERS TO TOWN

Un service régulier d'autobus fonctionnera pendant la période du Congrès et assurera, toutes les heures, la liaison entre la ville et les locaux de l'Athénée Royal où se tiendront les assises des Congrès.

A regular bus service, running every hour, will assure a link between Congress Headquarters at the Royal Athenaeum and Town, during the whole period of the Congress.

Départ de l'Athénée à la trentième minute de l'heure.

Departures from the Athenaeum :

Horaires :

Time Table :

Salle du Collège Albert 1er	. h. 05
<i>Hall of the » »</i>	
Salle de cinéma du Service Information	. h. 07
<i>Cinema of the Information Service</i>	
Poste Centrale	. h. 10
<i>General Post Office</i>	
Hôtel Memling	. h. 15
Hôtel Régina	. h. 20
Hôtel Palace	. h. 25

Poste Centrale et retour à l'Athénée avec les mêmes arrêts.

From the General Post Office to the Athenaeum with the same stops.

RESTAURANTS

Astoria , Av. Charles de Gaulle, (menu : 70 francs)	Tél. 28.66
Luso , Av. Stanley, (spécialités portugaises, <i>Portuguese specialities</i>)	Tél. 28.75
Palace , Av. Paul Hauzeur, (menu : 65 francs)	Tél. 31.73
Le Galiéma , La Raquette, (menu : 150 francs, Orchestre, <i>Orchestra</i>)	Tél. 28.59
Au Glacier , Av. Ministre Rubbens, (Restaurant, hors-d'œuvre, sandwiches)	Tél. 30.66
Guest-House Sabena , Av. Olsen, (menu : 75 francs)	Tél. 34.90
Le Zoo , Jardin Zoologique, (menu : 75 francs)	Tél. 33.95
La Devinière , Binza, (menu : 150 francs, Orchestre, <i>Orchestra</i>)	Tél. 91.36
Le Petit-Pont , Av. Valcke à Kalina, (Friture, <i>Grill-Room</i>)	Tél. 27.83
« Chez Nous », Km. 11, Autostrade, Léo-Kenge, (Spécialités africaines, <i>African specialities</i>)	Tél. 46.62
Deux Ponts	
Auberge de la N'Gili	
Van Daele , Av. Tombeur de Tabora, 23	Tél. 27.35

PATISSERIES — TEA-ROOMS

Glaces — Ice creams

Au Glacier	Avenue Ministre Rubbens	Tél. 30.66
Pâtisserie Nouvelle	Avenue Beernaert	Tél. 22.71
Nicaise	Av. du Port	Tél. 31.39
Regina	Boulevard Albert Ier	Tél. 36.91
Le Zoo	Jardin Zoologique	Tél. 33.95
La Devinière	Binza	Tél. 91.36
Grandes Boulangeries , Av. du marché		Tél. 33.03
Moka d'Or	Boulevard Albert	Tél. 23.23

NIGHT-CLUBS

La Devinière	Binza	Orchestre, dancing, restaurant	Tél. 91.36
Le Galiéma		Orchestre, attractions, dancing La Raquette (Kalina)	Tél. 28.59
Le Flamingo		Night-Club, dancing, attractions Avenue Hanssens	Tél. 25.60
Le Mirédo		Night-Club, dancing, attractions 12, Square du Marché	Tél. 24.15

TELEPHONE — CONGRES — PHONE

Secrétariat - <i>Secretariate</i>	3803
Accueil - <i>Reception</i> :	
Bureau - <i>Office</i>	4473 4555
Chef de Service - <i>Manager</i>	3801

CULTE CATHOLIQUE — CATHOLIC RELIGION

HEURES DES OFFICES RELIGIEUX — RELIGIONS OFFICES HOURS

Cathédrale Ste-Anne, Avenue des Aviateurs

Offices le dimanche - *On Sunday* : 5 h. 30 - 6 h. 30 - 7 h. 30 - 9 h. - 10 h.

Chapelle de Kalina (Lycée du Sacré-Cœur), Avenue Martin Ruttens

Offices le dimanche - *On Sunday* : 6 h. - 6 h. 45 - 7 h. 30 - 8 h. 30 - 9 h. 30

Chapelle Clinique Reine Elisabeth

Offices le dimanche - *On Sunday* : 7 h. 30 - 8 h. 30

Eglise St-Léopold, à Léo II

Offices le dimanche - *On Sunday* : 7 h. 30 - 8 h. 30

HORAIRE DES CULTES PROTESTANTS

Langue Néerlandaise	Chapelle de la B.M.S., Avenue Van Gèle, le 1er dimanche du mois 10 heures
	Armée du Salut, 23, Avenue Major Cambier, chaque dimanche 19.45 h.
Langue Française	Chapelle de la B.M.S., Avenue Van Gèle, chaque dimanche 11 heures
Langue Anglaise	Armée du Salut, 23, Avenue Major Cambier, le 2ème et le 4ème dimanche du mois 10.30 h.

TIME TABLE OF THE PROTESTANT RELIGIOUS SERVICE

French Language	Church of the B.M.S., Av. Van Gèle, every first Sunday of the month 10 o'clock
	Salvation Army, 23, Avenue Major Cambier, every Sunday 19.45 h.
English Language	Church of the B.M.S., Avenue Van Gèle, every Sunday 11 o'clock
Netherland Language	Salvation Army, 23, Avenue Major Cambier, every second and fourth Sunday of the month 10.30 h.



Vue aérienne du parc de la future résidence du Gouverneur Général du Congo Belge à Léopoldville. On distingue au second plan le bâtiment abritant les services du Gouvernement Général.

Aerial view of the Park of the future residence of the Governor General of the Belgian Congo in Léopoldville. One can distinguish in the background the building containing Services of the Government General.



NOTE SUR LE SERVICE METEOROLOGIQUE

Le Service Météorologique du Congo Belge et du Ruanda-Urundi se compose de deux sections groupant l'une les activités de météorologie climatologique et synoptique, y compris la protection des aéronefs, l'autre les activités instrumentales, atmophysiques et géophysiques, y compris les sondages de l'atmosphère.

Le fonctionnement des premières de ces activités est assuré par le centre climatologique de Binza et par les trois bureaux du temps de Léopoldville, Stanleyville et Elisabethville; ces organismes exploitent les renseignements venus d'un réseau d'une centaine de stations synoptiques (transmettant leurs observations par radio) et de quelque sept cents stations pluviométriques.

Les instruments destinés à ce réseau sont tous contrôlés, étalonnés, entretenus, réparés par le laboratoire de Binza, lequel est assisté par divers ateliers (mécanique, horlogerie, électronique). La station fondamentale d'aérologie de Binza procède à des sondages quotidiens de l'atmosphère jusqu'à l'altitude de 15 à 20 km.; une quinzaine de stations plus modestes, incorporées au réseau, procèdent de même à des sondages de vent jusqu'à 8 à 10 km.

A Binza se trouvent également les bureaux centraux de rayonnement solaire et de magnétisme terrestre, dont dépendent les observatoires d'Elisabethville et de Stanleyville. Du bureau de magnétisme dépend aussi une mission itinérante qui parcourt le Congo et procède à des mesures systématiques de magnétisme et de gravitation.

NOTES ON THE METEOROLOGICAL SERVICE

The Meteorological Service of the Belgian Congo and Ruanda-Urundi is composed of two sections — one grouping the activities of climatological and synoptical meteorology including aircraft protection; the other section the instrumental, atmophysical and geophysical activities including atmospheric soundings.

The functioning of the first of these activities is assured by the climatological centre in Binza and by the three weather offices of Leopoldville, Stanleyville and Elisabethville. These organisms use information coming from a network of a hundred sunoptical stations (who transmit their observations by radio) and from more or less 700 rain-gauging stations.

The instruments used by this network are all controlled, calibrated, kept in good working order and repaired, by the Binza laboratory which is assisted by various workshops (mechanical, clock-making, electronic). The fundamental aerological station of Binza does daily atmospheric soundings up to the altitude of 15-20 kms ; about 15 smaller stations incorporated in the network do wind soundings, up to 8-10 kms.

In Binza are also the central offices dealing with sun radiation and terrestrial magnetism on which the observatories of Elisabethville and Stanleyville depend. An itinerant mission which travels over the Congo and does systematic magnetism and gravitation gauges depends on the magnetism bureau.



CLIMAT DE LEOPOLDVILLE CLIMATE OF LEOPOLDVILLE

Tableau comparatif des degrés centigrades et Fahrenheit.
Equivalent table of Fahrenheit and centigrades degrees.

F	C
32	0
50.2	10
59	15
68	20
69.8	21
71.6	22
73.4	23
75.2	24
77	25
78.8	26
80.6	27
82.4	28
84.2	29
86	30

LE CLIMAT DE LEOPOLDVILLE

THE CLIMATE OF LEOPOLDVILLE

	RR	P	M	M	m	m	T
J	132	8.1	30.5	35.0	21.6	18.4	25.5
F	160	10.3	30.8	35.3	21.6	18.9	25.5
M	228	13.9	31.4	35.2	21.7	18.6	25.9
A	216	12.6	31.7	35.8	21.9	17.1	25.8
M	120	9.0	30.6	34.5	21.2	16.8	25.2
J	3	0.7	28.6	34.4	18.7	15.2	23.3
J	0,6	0.3	27.0	32.4	17.1	11.9	21.9
A	8	0.9	28.2	34.2	7.7	12.4	23.0
S	44	4.8	30.3	35.5	19.9	15.8	24.8
O	203	9.8	30.6	35.8	21.3	18.3	25.3
N	270	14.9	30.3	35.0	21.4	18.8	25.0
D	149	13.2	30.2	34.4	21.4	18.6	21.1

AGENDA LEGEND

RR : Précipitation totale moyenne mensuelle en mm. — *Total average monthly rainfall in mm.*

P : Nombre moyen de jours de pluie en jours et dixièmes. — *Average number of days of rain in days and tenths.*

M : Moyenne des maxima de température en °C. — *Average maximum temperature in °C.*

m : Moyenne des minima de température en °C. — *Average minimum temperature in °C.*

M : Maximum absolu de température en °C. — *Absolute maximum temperature in °C.*

m : Minimum absolu de température en °C. — *Absolute minimum temperature in °C.*

T : Température moyenne. — *Average temperature.*

REMARQUE REMARK

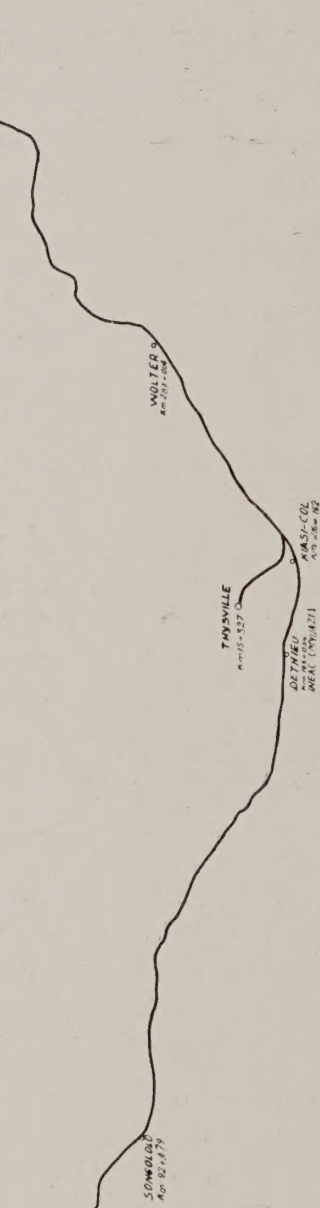
Les données portent sur 10 années d'observations pour les mois de janvier à avril sur 9 ans pour les mois de mai à décembre.

The above are taken from 10 years of observation for the months of January to April and 9 years for the months of May to December.

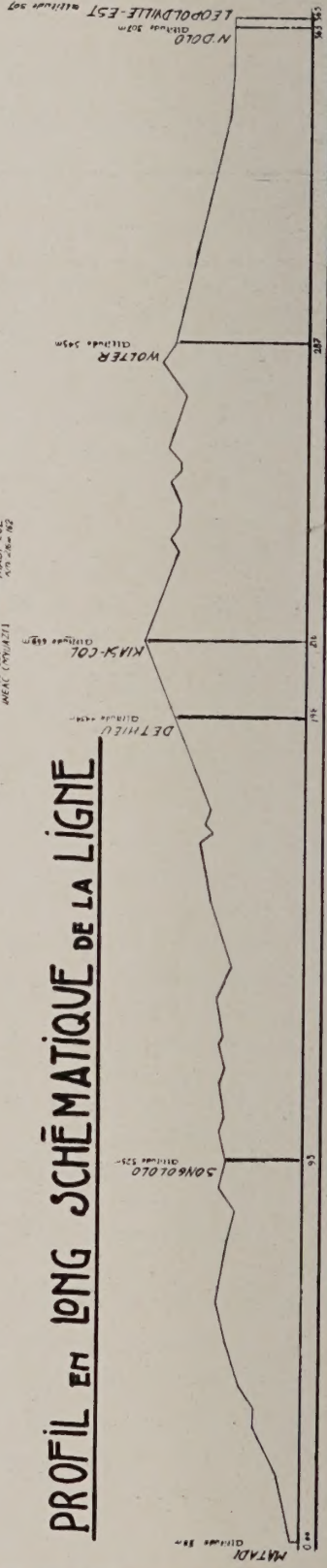
OFFICE D'EXPLOITATION DES TRANSPORTS • COLONIAUX.

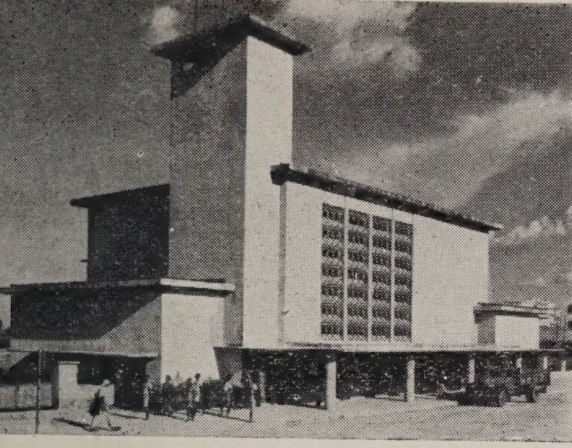
CHÉMIN DE FER DE MATADI À LÉOPOLDVILLE

TRACÉ SCHEMATIQUE DE LA LIGNE.



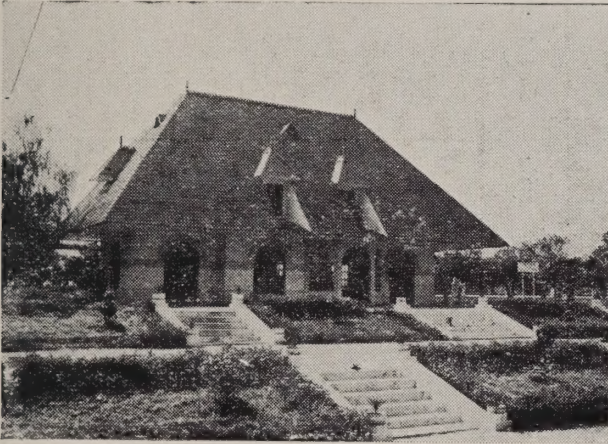
PROFIL EN LONG SCHEMATIQUE DE LA LIGNE





Quelques gares :
Some Railway
stations :

Léopoldville



Cattier

Songololo



Matadi



TARIFS POSTAUX — POSTAL TARIFS

Pays	AVION — AIR-MAIL				BATEAU — BOAT			
	Cartes postales	Lettres	Imprimés (50 gr.)		Cartes postales	Lettres	Imprimés (5 gr.)	Journaux
Countries	Post-cards	Letters	Printed Matter		Post-cards	Letters	Printed Matter	Newspapers
AFRIQUE								
Afrique du Sud	1,95	3,75	1,20		1,20	3,—	0,80	0,60
A. E. F.	1,95	3,75	1,20		1,20	3,—	0,80	0,30
A. O. F.	3,50	5,50	2,20		2,50	4,50	1,80	1,20
Algérie	3,50	5,50	1,80		2,50	4,50	1,80	0,90
Angola	1,95	3,75	2,20		1,20	3,—	0,80	0,30
Congo Belge & R.-U.	1,20	3,—	0,40 + 1fr. par 25 gr.		1,20	3,—	0,40	0,85
Kenya	1,95	3,75	1,20		1,20	3,—	0,80	0,30
Libéria	3,50	5,50	2,20		2,50	4,50	1,80	0,90
Madagascar	1,95	3,75	1,20		1,20	3,—	0,80	0,30
Maroc	3,50	5,50	2,20		2,50	4,50	1,80	0,90
Mozambique	1,95	3,75	1,20		1,20	3,—	0,80	0,30
Uganda	1,95	3,75	1,20		1,20	3,—	0,80	0,30
Rhodésie S. & N.	1,95	3,75	1,20		1,20	3,—	0,80	0,30
Tanganyika	1,95	3,75	1,20		1,20	3,—	0,80	0,30
Tunisie	3,50	5,50	2,20		2,50	4,50	1,80	0,90

AMERIQUE

Brésil	7,50	9,50	3,40	2,50	4,50	1,80	2,15
Canada	7,50	9,50	3,40	2,50	4,50	1,80	0 90
Colombie	7,50	9,50	3,40	2,50	4,50	1,80	0 90
Etats-Unis	7,50	9,50	3,40	2,50	4,50	1,80	0 90

ASIE

Japon	8,—	10,—	3,55	2,50	4,50	1,80	2,40
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EUROPE

Allemagne	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Autriche	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Danemark	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Finlande	5,50	7,50	2,80	2,50	4,50	1,80	1,65
France	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Grande-Bretagne	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Italie	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Pays-Bas	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Portugal	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Suède	5,50	7,50	2,80	2,50	4,50	1,80	1,65
Suisse	5,50	7,50	2,80	2,50	4,50	1,80	1,65

OCEANIE

Australie	9,50	11,50	4,30	2,50	4,50	1,80	1,65
Malaisie	9,50	11,50	4,30	2,50	4,50	1,80	2,90

PHILATELIE — PHILATELY

Un tableau des différentes valeurs postales en usage sera exposé au bureau postal du hall d'accueil.

Specimens of the different Belgian Congo postage stamps, in actual use, will be exhibited at the entrance of the Reception Hall.

GARAGES

A. C. A. , Av. Van Gèle, (Pontiac, Oldsmobile, Vaux hall) .	Tél. 42.33
Cegeac , Av. Tombeur de Tabora, (Ford, Mercury, Lincoln) .	Tél. 24.52
Central , Av. Major Cambier	Tél. 27.21
C. F. A. O. , Av. Prince de Liège, (Citroën, Hudson)	Tél. 26.53
Difco , Av. Ministre Rubbens, (Studebaker, Volkswagen) . .	Tél. 32.20
Duncan Smith , Av. Van Gèle (Humber, Austin, Morris, Jaguar, Sunbeam)	Tél. 33.07
Lusitania , Av. Major Cambier, (Peugeot)	Tél. 22.51
N. A. H. V. , Av. Olsen, (Dodge, Plymouth)	Tél. 22.44
Pool , Av. Van Gèle, (Fiat, Simca, Packard)	Tél. 25.25
Sedec , Av. Georges Bousin, (Chevrolet, Opel, Buick)	Tél. 36.31
Socoli , Av. Beernaert, (De Soto)	Tél. 35.58
Unimer , Av. de la Bouteillerie, (Mercedès)	Tél. 27.66

CINEMAS

Cinéma « Studio Albertum » , avenue Ministre Rubens	Tél. 32.90
Cinéma Palace , avenue Charles de Gaulle	Tél. 28.03
Ciné-Studio « R.A.C. » , avenue des Aviateurs	Tél. 26.01
Ciné « Petit Pont » , avenue Valcke	Tél. 27.83
Ciné Albert Ier , avenue Marie-José, Kalina	Tél. 20.05
Ciné Roxy , avenue Vice-Gouverneur Engels	Tél. 32.90

COMMUNICATIONS

Vedette Léopoldville-Brazza	— Premier départ 6 h. 30 et puis toutes les 1/2 heures. Entre midi et 14 heures pas de service. <i>First start : 6 h. 30 and every half an hour.</i> <i>From 12 to 14 no service.</i>
Train Léopoldville-Matadi	<i>Departure every day at 7 h. 15 — On Sunday no departure.</i> — Départ tous les jours à 7 h. 15 — Sauf dimanche.
Léopoldville-Stanleyville par Otraco	— Départ les 31/7 - 7/8 - 14/8 - 28/8 - 4/9, etc.

CONSULATS — CONSULATES

Afrique du Sud , M. Bower, Building Forescom	Tél. 33.75
Allemagne , M. Aufermann, Binza - B.P. 2288	Tél. 91.92
Amérique , M. Mac Gregor, Avenue Olsen	Tél. 28.10
Autriche , M. Visez, 34, Avenue Banning	Tél. 31.45
Canada , M. Brodie, Building Forescom	Tél. 27.06
Danemark , M. Meeus, Building Forescom	Tél. 22.60
France , M. Lorion, 38, Avenue Banning	Tél. 32.41
Finlande , M. Sion, B.P. 101 - Léo	Tél. 36.61
Grande-Bretagne , M. Boyd Tollinton, Boulevard Albert 1er	Tél. 32.80
Grèce , M. de la Kethulle, Avenue des Sénégalais	Tél. 27.75
Italie , M. d'Alessandro, 8, Avenue Costermans	Tél. 34.16
Libéria , M. J.L. La Gro, 16, Avenue Cerckel	Tél. 28.76
Norvège , M. de Cressonières, Avenue des Aviateurs	Tél. 25.78
Pays-Bas , M. van den Brandeler, 11, Avenue Ponthier	Tél. 27.13
Portugal , M. Futsher Pereira, Avenue Tombeur de Tabora	Tél. 22.37
Suède , M. Zander, Avenue Colonel Van Gèle	Tél. 31.05
Suisse , M. Curchod, 21, Avenue Stanley	Tél. 22.85
Tchéco-Slovaquie , M. Klouda, Avenue 8ème Armée	Tél. 21.19

COIFFEURS — HAIRDRESSERS

Michaux , Av. du Port, (Messieurs - <i>Gentlemen</i> , Dames - <i>Ladies</i>)	Tél. 32.70
Queiroz , Av. Renkin, (Messieurs - <i>Gentlemen</i>)	Tél. 21.46
Luis Philip (De Campos), 26, Av. de Gaulle (Messieurs - <i>Gentlemen</i>)	Tél. 21.89
Maurice , Bd Albert 1er	Tél. 31.50
Regina , Hôtel Regina, Bd Albert 1er (Messieurs - <i>Gentlemen</i> , Dames - <i>Ladies</i>)	Tél. 36.91
Mme Viaene , Av. Stanley (Memling)	

SPORTS

Tennis	Funa Club
Golf	Golf Club
Miniature Golf	Funa Club
Hippisme Horse back riding	Cercle Hippique
Natation	Funa Club
Swimming	

Les participants aux Congrès sont, pendant leur séjour à Léopoldville, les invités de ces cercles dont ils peuvent fréquenter les installations sur simple présentation de leur insigne de congressiste.

Congress members will be the guests of these clubs, during their stay in Leopoldville. They will be allowed any facilities and accomodations on presenting their Congress badges.

BANQUES — BANKS

Banque Centrale du Congo Belge et du Ruanda-Urundi , Av. des Aviateurs	Tél. 36.53
Banque Belge d'Afrique (B.B.A.), Av. Ministre Rubbens . . .	Tél. 36.61
Banque du Congo Belge (B.C.B.), Av. Paul Hauzeur	Tél. 39.41
Bureau dans le Hall d'accueil.	
Banque Nationale pour le Commerce et l'Industrie (B.N.C.I.), Av. des Aviateurs	Tél. 25.51
Crédit Congolais , Av. des Aviateurs, 12	Tél. 25.78
Kredietbank , Av. Cerckel, 20	Tél. 42.41
Société Congolaise de Banque (Socobanque), Rue Allard l'Ollivier	Tél. 28.81
Banque de Paris et des Pays-Bas , Forescom Building	Tél. 45.61

MONNAIE - CHANGES

L'unité monétaire officielle est le franc congolais, divisé en 100 centimes. La Colonie et la Métropole ont un régime monétaire bien distinct, quoique les deux unités monétaires soient équivalentes et que le Congo appartienne à la zone monétaire belge.

L'étalon-or est à la base du système monétaire.

Sont en circulation les pièces de 50 centimes et de 1, 2, 5 et 50 francs (cette dernière en alliage d'argent).

La Banque Centrale du Congo Belge et du Ruanda-Urundi émet des billets de banque ; les coupures sont de 5, 10, 20, 50, 100, 500 et 1.000 francs.

Le système métrique est en vigueur pour les poids.

Le taux des changes pour les pays ci-après sont par rapport au franc congolais de :

MONEY AND EXCHANGE

The official monetary unit is the Congolese franc which is divided into 100 centimes. The colony and the metropolis have a distinct monetary system although the two monetary units are equivalent and the Congo belongs to the Belgian monetary zone.

The gold standard is at the base of the monetary system.

The following coins are in circulation: 50 centimes, 1, 2, 5 and 50 francs (the latter is of silver alloy).

The Central Bank of the Belgian Congo and Ruanda-Urundi issues bank notes. The denominations are: 5, 10, 20, 50, 100, 500 and 1.000 francs.

The metric system is used for weight.

The exchange tariff for the following countries are in relation to the Congolese francs :

Pays <i>Countries</i>	Monnaie <i>Money</i>	Equivalence en francs congolais <i>Equivalent in Congolese francs</i>
Afrique du Sud <i>South Africa</i>	livre	1 livre Sud-Africaine = 140 frs congolais
Allemagne <i>Germany</i>	mark	1 deutsche mark = 12 frs congolais
Angleterre <i>England</i>	livre-sterling	1 livre sterling = 140 frs congolais
Australie <i>Australia</i>	livre	1 livre australienne = 112 frs belges
Autriche <i>Austria</i>	shilling	1 shilling = 1 fr. belge
Belgique <i>Belgium</i>	franc	100 francs belges = 100 frs congolais
Brésil <i>Brazil</i>	cruzeiros	100 crouzeiros = 94 frs congolais
Canada <i>Canada</i>	dollar	1 dollar canadien = 51 frs congolais
Colombie <i>Colombia</i>	peso	100 pesos = 190 frs belges
Danemark <i>Denmark</i>	couronne	1 couronne danoise = 7 frs 25 congolais
Etats-Unis <i>United States</i>	dollar	1 dollar = 50 frs congolais
France <i>France</i>	franc	100 francs français = 14 frs 30 congolais
Finlande <i>Finland</i>	mark	100 marks finnois = 15 frs 25 congolais
Hollande <i>Holland</i>	florin	1 florin = 13 frs 25 congolais
Italie <i>Italy</i>	livre	100 lires = 8 frs 05
Japon <i>Japan</i>	yen	100 yens = 11 frs 50 congolais
Portugal <i>Portugal</i>	escudos	100 escudos = 174 frs congolais
Suède <i>Sweden</i>	couronne	1 couronne = 9 frs 75 congolais
Suisse <i>Switzerland</i>	franc	1 franc = 12 frs congolais
Turquie <i>Turkey</i>	livre	1 livre turque = 8 frs 50 congolais

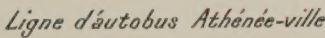


✠ Eglise Catholique

✠ Temple Protestant

— Excursion

○ Point d'arrêt



MEDECINS TRAITANTS ET DENTISTES COLONIE

Dr d'Antas Videira (Madame), Dispensaire mixte du Building Administratif.
Tel. : 2838.

De 7 h. 30 à 9 h. 30, tous les jours — *every day*.

Avenue Major Cambier, 47. Tel. : 3361 (portugais).

Dr Beheydt, Hôpital des Congolais, Léo-Est. Tel. : 3711. (Néerlandais, anglais, allemand).

Sur rendez-vous les lundi, mercredi, vendredi, de 14 à 17 h.

On appointment Mondays, Wednesdays and Fridays.

Dr Colaert, Hôpital Léo I. (Néerlandais). Radiographie.

Sur rendez-vous. — *On appointment*. (Dutch.)

Dr De Bisshop, avenue Lippens. Tel. : 3821.

De 7 h. 30 à 9 h. tous les jours. De 14 h. à 16 h. 30 tous les jours sauf le samedi. Avenue Lippens, 32. Tel. : 4114 (urgence). (Néerlandais, anglais et allemand — *Dutch, English, German.*)

Dr Drummel, avenue Major Cambier, 90. Tel. 3010.

De 2 h. à 3 h. le mardi et jeudi. Samedi à 2 h et 4 h. (Anglais, néerlandais — *English, Dutch.*)

Dr Leusch, Clinique Reine Elisabeth. Tel. 3503.

Tous les jours de 8 h. à 11 h. — *Every day from 8 to 11 a.m.*

Dr Pauly :

(a) Clinique Reine Elisabeth. Tel. : 2390.

De 7 h. à 9 h. tous les jours sauf mardi et samedi.

From 7 to 9 a.m. every day, except Tuesdays and Saturdays.

(b) Avenue Van Gèle. Tel. : 3494.

De 14 h. à 16 h. tous les jours, sauf samedi.

From 2 to 4 p.m. every day, except Saturday.

(Allemand, anglais — *German, English.*)

Dr Pirquin, à son domicile, boulevard Léopold II, No 32. Tel. : 3494.

De 14 h. à 16 h. tous les jours, sauf le samedi.

From 2 to 4 p.m. every day, except Saturday.

Dr Weyts, oculiste, Clinique Reine Elisabeth. Tel. : 3503.

De 8 h. à 10 h. mardi et vendredi, — *From 8 tot 10 a.m. Tuesdays and Fridays.* — Sur rendez-vous lundi et jeudi, de 14 h. 30 à 18 h.

— *On appointment Mondays and Thursdays, from 2 h. 30 to 6 p.m.*

Hôpital Léo I. Tel. : 3711.

De 17 à 18 h. 30 mardi et vendredi. — *From 5 to 6.30 p.m. Tuesdays and Fridays.* (Néerlandais, allemand, anglais — *Dutch, German, English.*)

Dentiste Willems, Clinique Reine Elisabeth. Tel. : 3503.

De 7 h. 30 à 12 et de 14 h. à 16 h. 30 tous les jours.

From 7.30 to 12 a.m. and from 2 to 4.30 p.m. every day.

(Néerlandais, anglais, allemand — *Dutch, English, German.*)

MEDECINS PRIVES

Dr Gorecki, avenue Tombeur de Tabora, 53. Tel. 2369.

De 14 h. à 15 h. 30 mercredi, jeudi et vendredi; de 9 à 10 h. samedi.

From 2 to 3.30 p.m. Wednesdays, Thursdays and Fridays; from 9 to 10 p.m. Saturdays.

(Anglais, Néerlandais, allemand, polonais — *English, Dutch, German, Polish.*)

Dr Grégoire, avenue Major Cambier, 67. Tel. : 4222.

De 7 h. 30 à 8 h. 30 mercredi, jeudi, vendredi. — De 3 h. à 5 h. 30 tous les jours. — *From 7.30 to 8.30 a.m. Wednesdays, Thursdays, Fridays. Every day from 3 to 5.30 p.m. (Anglais — English.)*

Dr Demeulemeester, avenue Banning. Tel. : 3196.

De 8 h. à 9 h. tous les jours, sauf mercredi. — *From 8 to 9 a.m. every day, except Saturday. (Anglais, néerlandais, espagnol — English, Dutch, Spanish.)*

Dr Demkoff, avenue Valcke.

Sur rendez-vous de 8 h. à 9 h. 30 et de 4 h. à 5 h. 30. — *On appointment from 8 to 9.30 a.m. and from 4 to 5.30 p.m. (Anglais — English.)*

Dr Ghilain, Dispensaire de Kalina, avenue Lippens. Tel. : 3821.

De 7 h. 30 à 9 h. 30 tous les jours. — *Every day from 7.30 to 9.30 a.m.*

Avenue des Citronniers, No 1 (urgence).

Dr Prum, 95, Usoke. Tel. : 4215.

de 8 h. à 11 h. et de 2 h. à 4 h. tous les jours; de 9 h. à 11 h. le dimanche. — *From 8 to 11 a.m. and from 2 to 4 p.m. every day, Sundays from 9 to 11 a.m. (Anglais, allemand - English, German.)*

Rde Mère Raynaud, Clinique Reine Elisabeth.

Tous les jours de 9 h. à 11 h. — *Every day from 9 to 11 a.m.*

Dr Ruppel, Dispensaire Léo II. Tel. : 2628.

De 7 h. 30 à 10 h. tous les jours. — *From 7.30 to 10 a.m. every day. (Néerlandais, allemand. — Dutch, German.)*

Dr Staub, 31, avenue Major Cambier.

De 15 à 16 h. tous les jours. Sur rendez-vous samedi, dimanche, de 11 à 12 h. — *From 3 to 4 p.m. everyday. On appointment Saturdays and Sundays from 11 to 12 midday. (Allemand — German.)*

Dr Tenret (Madame), avenue Lippens, 19. Tel. : 3999.

Lundi, mercredi, vendredi de 2 h. à 4 h. — *Mondays, Wednesdays and Fridays from 2 to 4 p.m.*

Dr Thanhoffer, 10, avenue Costermans. Tel. : 4620.

De 8 h. à 10 h. et de 3 h. à 4 h. tous les jours sauf samedi. — *From 8 to 10 a.m. and from 3 to 4 p.m. every day, except Saturday. (Hongrois, anglais, allemand. — Hungarian, English, German.)*

Dr Tiprus, avenue du Lac, No 8, Léo II. Tel. : 2118.

De 4 h. à 6 h. tous les jours, sauf le samedi. — *From 4 to 6 p.m. every day, except Saturday. (Russe, allemand, roumain — Russian, German, Rumanian.)*

Dr Van Meerbeeck, avenue des Sénégalais, 16. Tel. : 3172 et 2943.

De 2 h. à 4 h. tous les jours et le matin sur rendez-vous. — *From 2 to 4 p.m. every day, on appointment in the morning. (Néerlandais, anglais. — Dutch, English.)*

Dr Weimerkisch (Madame), Binza. Tel. : 4905; ext. 9204.

De 9 h. à 11 h. tous les jours à Limete Boulonnerie; de 3 h. à 6 h. à Binza. — *From 9 to 11 a.m. every day at Limete Boulonnerie and from 3 to 6 at Binza. (Anglais, allemand — English, German.)*

DENTISTES — DENTISTS

- Clinique dentaire kinoise.** Dr Pagiavlas, Dr Cassalette, 19, avenue du Port. Reçoit sur rendez-vous. *Receives on appointment.* Langues : Français. *Languages : French.* Tél. 27-49
- Odobachian.** 21, avenue Tombeur de Tabora. Reçoit sur rendez-vous. *Receives on appointment.* Langues : Fr. *Languages : French.* Tél. 27-26
- Rochette.** 27, avenue Major Cambier. Reçoit sur rendez-vous. *Receives on appointment.* Langues : Fr., Angl. *Languages : French, English.* Tél. 27-29
- Dr Rosu.** 5, avenue Joséphine-Charlotte. Reçoit sur rendez-vous. *Receives on appointment.* Langues : Fr., Angl., All. *Languages : French, English, German.* Tél. 20-48
- Yperifanos.** 73, avenue de Gaulle. Reçoit de 7 heures à 20 heures. *Receives from 7 o'clock till 8 P.M.* Langues : Français, Grecque, Portugais, Anglais. *Languages : French, Greek, Portuguese, English.* Tél. 42-12

PHARMACIES — CHEMISTS

- Centrale,** Avenue du Plateau Tél. 20.20
- Coloniale,** Boulevard Albert 1er Tél. 43.40
- Cophaco,** 13, Avenue Beernaert Tél. 27.24
- Dubois,** Avenue Prince Baudouin Tél. 24.88
- Socophar,** 3, Avenue Cerckel Tél. 28.45
- Socophar,** 22, Avenue Charles de Gaulle Tél. 32.19
- Unicongo,** 30, Avenue Beernaert Tél. 24.44
- Unicongo,** Avenue du Kwango - Léo Ouest Tél. 24.45
- Unicongo,** Avenue Joséphine-Charlotte - Kalina Tél. 24.47

LIBRAIRIES — BOOKSELLER'S SHOPS

- Librairie Collignon,** 14, Avenue Beernaert Tél. 25.23
- Librairie Congolaise,** 12, Avenue des Aviateurs Tél. 37.48
- Librairie Desclée,** Boulevard Albert 1er Tél. 27.23
- Librairie Evangélique** (*English spoken*), Avenue Banning Tél. 22.02
- Librairie Impériale,** 5, Avenue Paul Cerckel Tél. 27.48
- Librairie « De Standaard »,** Résidence des Nations

Une succursale de la *Librairie Congolaise* sera installée dans le Hall d'accueil.

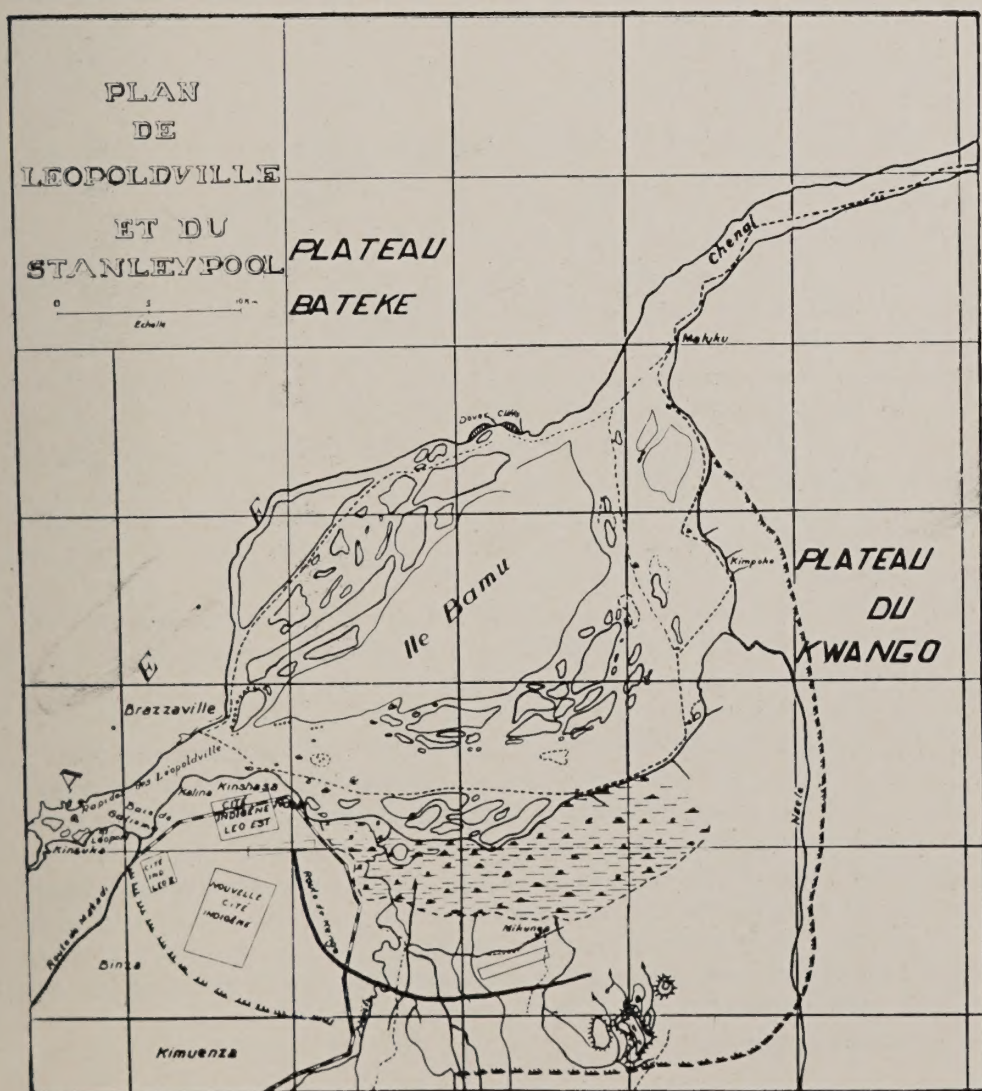
A branch of the bookstore « Librairie Congolaise » will operate in the Reception Hall.

PROMENADE GEOLOGIQUE A LEOPOLDVILLE

La ville de Léopoldville est bâtie sur la rive gauche du Fleuve Congo, face à Brazzaville, capitale de A.E.F. Les deux capitales se trouvent au début du retrécissement de l'énorme expansion, le Stanley-Pool, provoquée par un seuil qui le barre à l'aval, et au travers duquel, récemment, le Fleuve a taillé son déversoir : les rapides de Kinsuka.

On peut difficilement s'imaginer ce que pouvait représenter cette expansion à l'époque où ce seuil barrait complètement la route à l'évacuation des eaux drainées de toute la superficie du bassin du Congo, ni quel était le réseau hydrologique.

Le Stanley-Pool ne serait que le vestige de cette expansion « fossile » et, même réduit, il frappe actuellement l'imagination et émeut par sa grandeur tranquille et sa puissance latente.



Depuis que l'énorme lac a trouvé un déversoir, son fond est apparu en surface en quelques endroits ; l'île Bamu en serait un segment (E. Dupont) et, probablement, toute la plaine de Kinshasa.

Le Fleuve agit toujours ; c'est ainsi que la falaise de Kalina est condamnée à disparaître. Par contre, à l'Est, les dépôts récents ont comblé une partie du Pool et l'on voit nettement, sur une carte topographique, les zones déprimées successives dans lesquelles divague la rivière N'Jili.

La baie de Galiema et la dépression de la rivière Bandalungwa (Basoko), avec ses grès tendres, en est un autre exemple.

Vu à vol d'oiseau, le territoire occupé par Léopoldville est remarquable par la simplicité de ses formes : c'est une plaine basse bordée au Nord par le Fleuve et encerclée à l'Ouest et au Sud par un plateau ; la rivière N'Jili complète ses limites naturelles à l'Est.

PLAN GEOLOGIQUE DE LEOPOLDVILLE

Le sous-sol de Léopoldville a été exploré par plus de 400 sondages, en majorité faits par le Service Géologique. On y relève les formations suivantes :

1^o) Substratum : Grès rouge dit de l'Inkisi, appartenant au système schistogréseux de la carte géologique. Age inconnu (précambrien ?).

2^o) Formation de « grès tendres », réputés d'âge karroo.

Ces grès prennent des aspects différents :

a) presque massifs, sans stratification,

b) marqués par une stratification entre-croisée.

Les deux faces ci-dessus peuvent être blanchâtres, jaunâtres ou rougeâtres.

c) un niveau d'argilite calcarifère à fossiles (*Estheria*, *Esthériella* écailles de poissons) s'intercale localement entre le grès de l'Inkisi et le « grès tendre ».

3^o) Grès concrétionnés à ciment calcédonieux. Ce sont, en partie du moins, les « grès polymorphes » de la géologie congolaise.

Ces grès se présentent sous les aspects suivants :

a) En un banc continu, généralement à la surface ou près de la surface du sol. Lorsqu'il repose sur le « grès tendre » ou lorsqu'il y est intercalé, ce banc en est apparemment la silification superficielle. Il est considéré comme la réplique des « silcretes » du désert du Kalahari.

b) En plages disséminées dans l'épaisseur du « grès tendre », dont il est une silicification locale.

c) En blocs roulants parfois énormes.

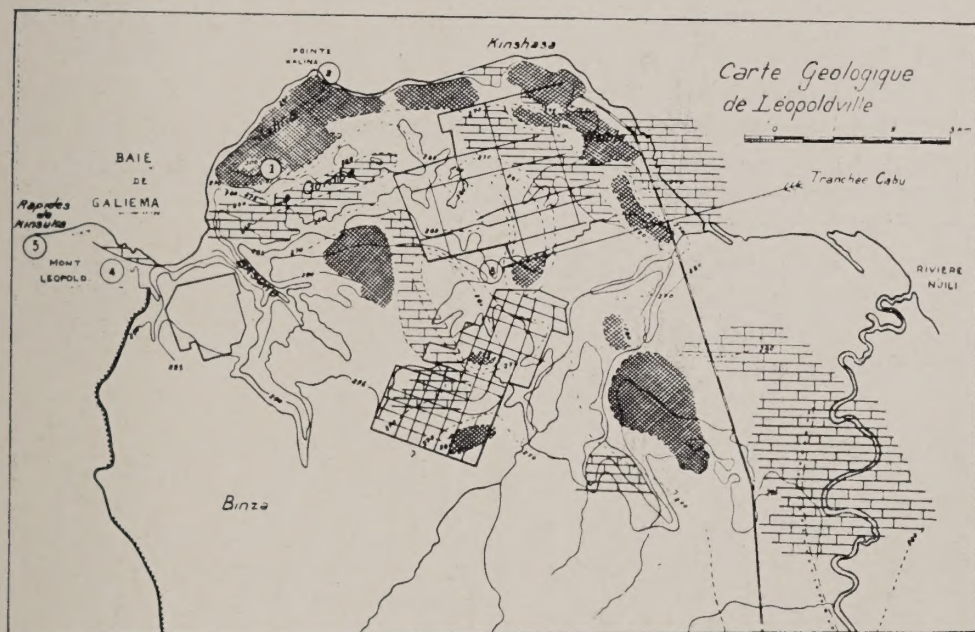
d) En blocs roulants polis et vernissés comme par des phénomènes désertiques.

4^o) Sables humifères.

- 5°) Limons ou sables argileux brunâtres, à grain moyen, avec, localement grenaille latéritique ou argile panachée en voie de latéritisation.
- 6°) Gravier composé de galets bien roulés de quartz hyalin, blanc-laiteux et rose, d'agate et d'oolithe silicifiée. Ces galets sont mêlés à des débris usés de « grès polymorphe » des 3°, c et d ci-dessus.
- 7°) Sables grossiers à grains variant de 0 à 5 mm. Ces sables ont donné des minéraux denses (disthène, staurotite, andalousite, etc.).
- 8°) Sables fins, mal classés, souvent blancs.
- 9°) Argile blanche, très fine, plastique.

Ces formations sont celles de la plaine de Léopoldville ; mais les hauteurs environnantes sont constituées par des sables rouges, bruns ou gris sans stratification.

La carte ci-dessous permet de rendre compte de la répartition de ces formations en tenant compte de ce qui suit :



Nous considérons que la plaine de Léopoldville se présente comme une réplique du Stanley-Pool actuel, où se relèvent des « îles » entre lesquelles serpentent des cheneaux fossiles du Fleuve. La succession dans les « îles » est complète : du grès rouge de l'Inkisi, on passe par le « grès tendre » (avec parfois l'argilite fossilifère à la base) aux grès calcédonieux en place ou en blocs roulants, le tout recouvert par du limon ou du sable, avec latérite.

Dans le fond des cheneaux les plus profonds, le sable grossier, avec le gravier (n° 6) repose directement sur le grès de l'Inkisi. Il est recouvert par l'argile blanche.

Sur les bords des chenaux, la succession caractéristique des « îles » est interrompue par ravinement, et se poursuit par le gravier et les sables grossiers.

En accord avec ce qui précède, un piéton se rendrait facilement compte de ce que la plaine de Léopoldville est loin d'être uniformément plane : il suffit de parcourir la ville en suivant le boulevard Albert depuis la gare, pour constater une montée à partir de l'hôtel Regina jusqu'au bâtiment de la Colectric, où commence une descente conduisant à la baie de Galiema. Un coup d'œil de la Clinique (point 1), point le plus élevé de la ville, jusqu'au camp militaire permet de constater que le boulevard occupe une longue dépression entre ces deux sites.

Cette dépression correspond à un des chenaux fossiles du Fleuve, qui aurait donc débouché dans la baie de Galiema. La colline de la Clinique et celle du camp militaire sont deux « îles » qui émergent actuellement du lit fossile, et permettent l'observation de la stratigraphie ci-dessus.

Les constructeurs de bâtiments se sont rendu compte que les fondations doivent être conditionnées suivant les endroits du territoire : ils ont vu parfois leurs fouilles toucher un banc de pierre très dure presque à la surface du sol, et d'autres fois, les puits profonds n'ont rencontré que du sable gorgé d'eau.

Le Service Géologique, grâce à l'étude du sous-sol par sondages et observations sur le terrain, est en mesure d'expliquer ces particularités tant en profondeur qu'en surface. Par contre il s'est heurté à d'autres complications qui ne sont pas encore éclaircies.

POINTE KALINA (point 2)

C'est le seul endroit de la rive du fleuve qui ne soit pas encore masqué par des constructions. C'est une falaise abrupte, à mi-hauteur de laquelle a été pratiqué un sentier étroit, passablement dangereux, sur lequel il ne s'agit pas de circuler en foule. On y accède par un escalier taillé dans la roche depuis la pelouse particulière de Monsieur le Gouverneur Général.

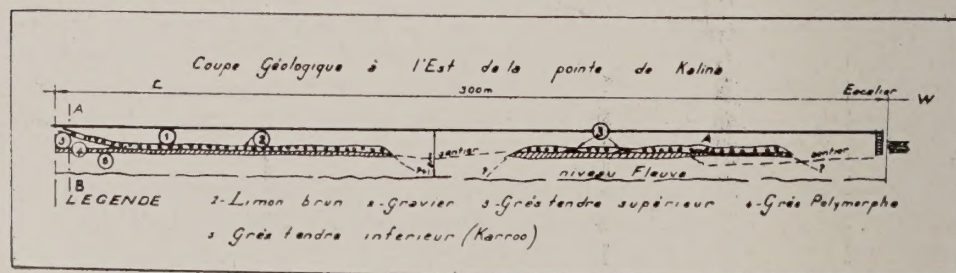


Fig. 1.

La coupe exposée présente la succession suivante, du niveau du fleuve à la pelouse :

- I. Grès tendre, grisâtre, massif.
- II. Grès polymorphe.
- III. Localement, grès tendre brun à rose, à zonages roses ou rouges ondoyants, mais sans stratification visible.
- IV. Gravier à galets de quartz, agate, oolithe, et blocs polis et vernissés de grès polymorphe, le tout mélangé du sable grossier.
- V. Grenaille latéritique.
- VI. Limon.

Remarques.

- a) Il n'existe pas encore de preuves sûres que les deux grès tendres encadrant le banc de grès polymorphe soient une seule et même formation.
- b) On ne connaît pas l'origine des blocs de grès polymorphe polis et vernissés : s'agit-il d'un second banc jamais vu encore en place, ou des débris d'un bombement, qui aurait existé plus au Sud, du banc présent dans la coupe ?
- c) On ne connaît pas, aux environs de Léopoldville à plus de 100 km. à la ronde, de formations contenant du sable aussi grossier, du conglomérat analogue, ou bien des roches pouvant fournir des agates, par exemple. Par contre, le gravier de Léopoldville est semblable au gravier diamantifère du Kasai.

Le sentier est établi en partie sur la dalle de grès polymorphe en corniche. En avançant sur le sentier, on voit le gravier rejoindre le grès polymorphe suivant une surface inclinée creusée dans le grès tendre supérieur qui est donc entièrement érodé à quelque douze mètres en aval de l'escalier.

Un banc de repos se trouve à 15 m. de l'endroit où le gravier plonge à travers le banc de grès polymorphe pour réapparaître 50 m. plus loin. Dans cet espace on ne voit plus que du limon. L'érosion a enlevé donc le grès supérieur, le grès polymorphe et une bonne partie du grès tendre inférieur. Il s'agit probablement d'un des cheneaux qui débouche dans le Fleuve en dehors de la baie de Galiema.

La grenaille latéritique est disparue aussi et se retrouve au-dessus du gravier sur le versant aval du chenal en même temps que le banc de grès polymorphe et le grès tendre inférieur.

Le gravier est continu dans la coupe : il est toujours étalé sur le grès polymorphe, où, de temps à autre, on voit des vestiges du grès tendre supérieur.

Au troisième escalier, le sentier descend sous le grès polymorphe, réduit ici à quelque 0,30 m. Il est établi dans le grès tendre inférieur, ce qui permet de constater une grande différence entre les deux bancs de grès tendre. Celui-ci est blanchâtre, beaucoup plus homogène, plus compact, affecté d'une stratification entrecroisée et de diaclases.

A cet endroit, sur la dalle de grès polymorphe, un lambeau de grès tendre supérieur montre un début de latéritisation au sein de la roche. Il y aurait donc deux niveaux de latéritisation d'âges différents, celui qui se trouve sur le gravier étant le plus ancien.

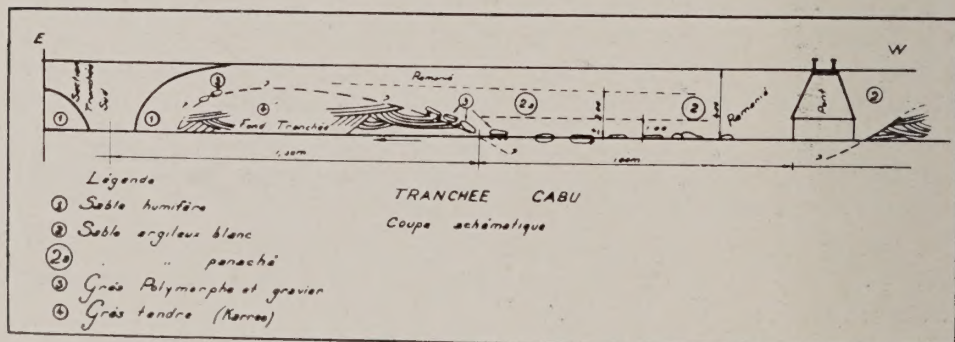
On descend encore trois marches et après quelques mètres, on perd de vue le gravier et le grès polymorphe pour le retrouver à la fin du trajet, en blocs éboulés et en place, en épaisseur exagérée et inattendue, au point où un escalier remonte vers la pelouse.

En résumé, les falaises de Kalina révèlent :

- 1^o) Un niveau de silicification qui indique un changement des conditions du milieu consécutif à l'émersion du grès tendre.
- 2^o) Des conditions continentales caractérisées par une érosion très vive et par des eaux d'un régime violent, capables de transporter des blocs très volumineux de roches.
- 3^o) De nouvelles conditions climatiques permettant la latéritisation.
- 4^o) Une période d'immersion caractérisée par le dépôt du limon.
- 5^o) Une période actuelle, avec ses propres caractères d'érosion et latéritisation.

TRANCHEE CABU (point 3)

Cette tranchée devait drainer toute la cité indigène de Léopoldville. Elle est apparue insuffisante au but poursuivi et, actuellement, les services de la ville exécutent un vaste programme de drainage général de la plaine de Lemba. La tranchée elle-même sera prolongée, élargie et rectifiée. Telle quelle, elle permet des observations très intéressantes. Un tronçon, depuis le pont, qui se trouve dans l'axe de l'avenue Baudouin jusqu'au confluent avec une autre tranchée venant du Sud, soit sur une longueur de près de 200 m. montre ce qui suit :



Sur une hauteur d'environ 4 m., les fouilles ont exposé du sable moyen argileux blanc avec, au fond de la tranchée, du grès polymorphe. On n'y voit aucune stratification ; le grès polymorphe est en blocs disjoints.

Ce sable est affecté d'un zonage brunâtre en traînées subhorizontales interrompues, espacées et irrégulières. A partir de 1 m. de hauteur au-dessus du fond de la tranchée, apparaissent des taches brun-rouge qui se poursuivent en s'intensifiant jusqu'à 2,5 m. - 3 m., où l'on peut voir la grenaille latérique se poursuivre vers l'aval parallèlement au fond de la tranchée. Il s'agit d'argile panachée ou « mottled clay ».

Au-dessus de la latérite il existait du limon qui, actuellement, a été enlevé par les travaux de rectification, de sorte que l'on ne peut voir nettement la relation limon-grenaille ; en plus, les déblais récents de la tranchée même sont étalés en surface.

A 90 m. en aval du pont, on observe sous les blocs de grès polymorphe un mince niveau de gravier et de sable grossier. D'ailleurs, cet ensemble se relève rapidement et l'on voit le gravier reposer sur un grès blanc-jaunâtre, compact, à stratification entrecroisée et diaclasée, en tous les points comparable au grès tendre inférieur de la pointe de Kalina.

On a donc traversé un chenal comblé par du sable argileux, qui s'étale sur le grès tendre en aval du pont.

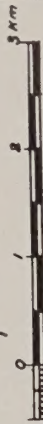
A environ 200 m. du pont, au confluent de la tranchée Cabu et de la tranchée Sud, on voit des blocs chaotiques de sable brun-noir humifère, vestiges d'un ancien marais desséché.

L'étude générale des sondages a permis de constater que ce sable humifère repose sur le sable grossier aquifère des chenaux ; il est donc probable que ce soit ici l'indice de passage d'un autre chenal.

En résumé, cette coupe présente une certaine analogie avec la falaise de Kalina, sauf en ce qui concerne le remplissage du chenal par un élément nouveau, sable argileux blanc sans limon, en voie de latéritisation.

Or, les sondages sur le plateau de Kalina ont montré que du limon repose sur un sable kaolineux blanc panaché, en voie de latéritisation, et sur un grès polymorphe. Ceci semble démontrer l'analogie des coupes, et établir la provenance de la grenaille latéritique au-dessus de gravier, qui pourrait donc être colluviale aux falaises de Kalina.

Carte Géologique de Léopoldville



+ SITES PRÉHISTORIQUES.

Tranchée Cabu

RIVIERE
N'JILI

Kinsasa

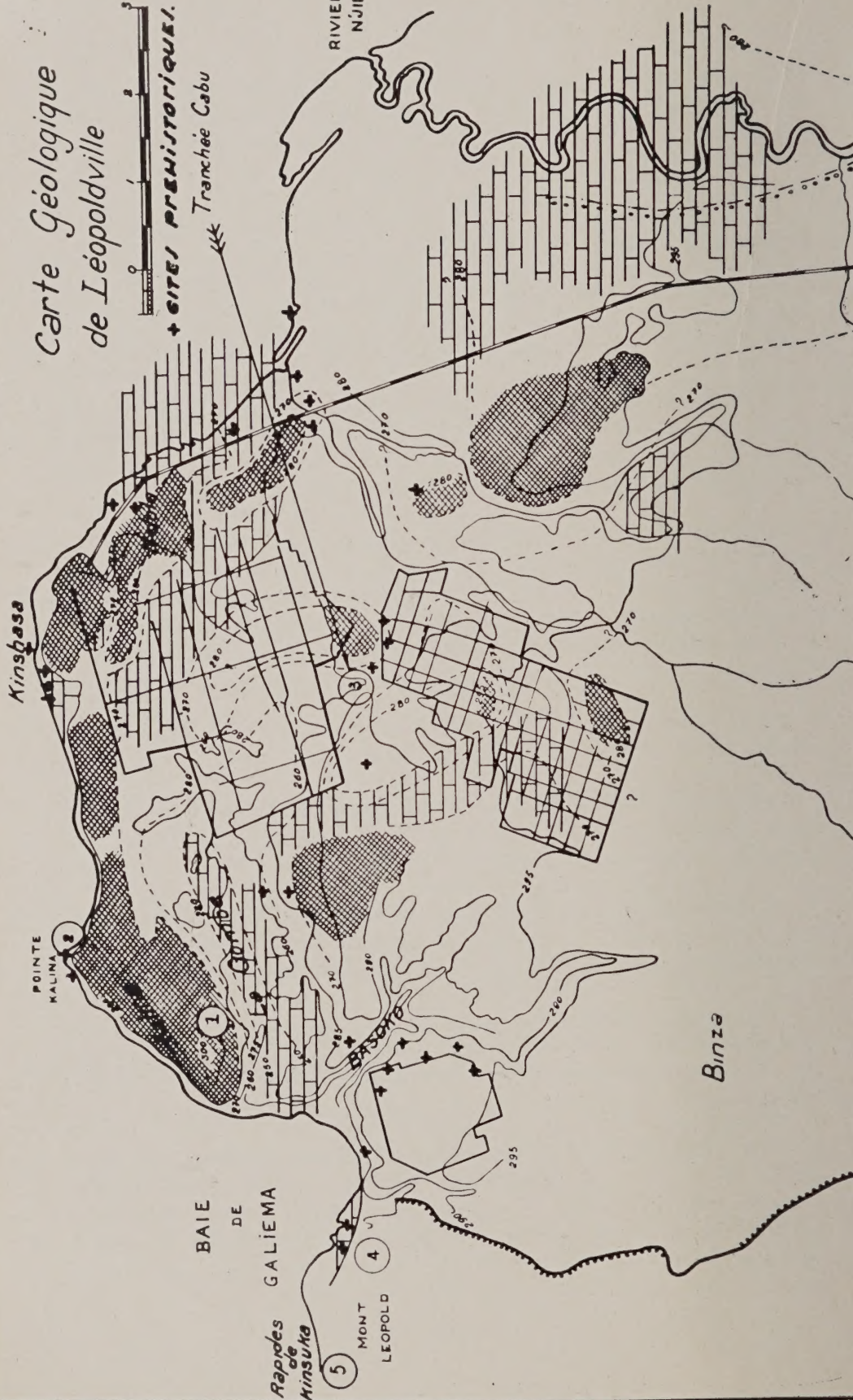
POINTE
MALINA

BAIE
DE
GALIEMA

Rapides
de
Kinsuka

MONT
LEOPOLD

Binza



MONT LEOPOLD (point 4)

Du Mont Léopold, on jouit d'une belle vue sur l'ensemble Léopoldville.

On distingue le Stanley-Pool et l'île Bamu à gauche et dans le fond, et, plus à gauche encore, le plateau Bateke. Par temps clair, on aperçoit au pied de ce dernier les falaises de sable blanc dénommées, par Stanley, « Dover cliffs ». A gauche et à nos pieds, le plateau de Brazzaville.

Léopoldville fait bien voir le plateau de Kalina (pendant du plateau de Brazzaville) et l'éminence du camp militaire. Entre les deux, se présente, en enfilade la vallée de la Gombe qui suit un ancien chenal du Fleuve (dont il a été question au point 1).

Ce chenal débouche dans la baie de Galiema, qui se développe à nos pieds.

Tout au fond, par temps clair, on soupçonne les contreforts du Kwango avec les falaises de sable rouge. Un peu en avant, le pic Mense et ses falaises blanches. Ce pic est un avant poste du Kwango.

Enfin, à droite, le cirque se ferme par les contreforts du plateau de Binza et de Kimwenza.

GRANDE CORNICHE (point 5)

De l'extrémité Ouest du Mont Léopold — plateau des cent maisons —, on jouit d'une belle vue sur les rapides de Kinsuka. Ces rapides coulent sur le grès rouge de l'Inkisi.

En descendant la route de la grande Corniche, on voit, vers le bas, le cailloutis de base des limons reposer sur le grès de l'Inkisi.

Ce cailloutis est l'homologue du niveau 6 de la pointe Kalina.

SERVICE GEOLOGIQUE

Juillet 1954

GEOLOGICAL EXCURSION IN LEOPOLDVILLE

The city of Leopoldville, built on the left bank of the Congo River, faces Brazzaville, capital of French Equatorial Africa. The two capitals are situated where the enormous river expansion — the Stanley Pool — begins to narrow. The expansion of the river was caused by a rock mass that barred it at its downstream end and through which the river recently carved its overflow, today known as the rapids of Kinsuka.

It is difficult to imagine what this vast expansion looked like at the time when this sill completely locked the outlet of all the water drained from the whole Congo Basin, nor what the hydrological network was like.

Even if the Stanley Pool is only what remains of this «fossil» expansion, in its reduced state it still strikes the imagination and moves one by its quiet grandeur and its latent power.

Since this enormous lake has found an outlet, its bottom has appeared in several places: the Bamu Island (E. Dupont) and probably the whole Kinshasa plain are parts of it.

The River is always moving: as an example, the Kalina cliffs are condemned to disappear. To the East, on the other hand, recent deposits have filled up part of the Pool. On a topographic map one can clearly see the successive depressed areas through which the N'jili River wanders.

Another example is the Galiema Bay and the depression of the Bandalungwa River (Basoko) with its soft sandstone.

A bird's eye view of the area occupied by Leopoldville shows the remarkable simplicity of its shape. It is a low plain bordered to the North by the Congo River, strounded to the West and South by a plateau, while, in the East, the N'jili River outlines its natural boundary.

GEOLOGICAL PLAN OF LEOPOLDVILLE

The subsoil of Leopoldville has been explored by more than 400 borings, mostly drilled by the Geological Service. The following formations have been observed:

- 1°) Substratum: Red sandstone, called Inkisi sandstone, belonging to the schist-sandstone system of the geological map. Age unknown (pre-Cambrian)?
- 2°) Soft sandstone formation, said to be of the Karroo age.
This sandstone take on different appearances:
 - a) nearly massive, devoid of stratification,
 - b) marked by cross-bedding.
Both facies can be white, yellowish or reddish.
 - c) a calcariferous fossil-bearing argilite layer (*Estheria*, *Estheriella* and fish scales) locally interbedded between the Inkisi sandstone and the «soft sandstone».
- 3°) Concretionary sandstone with chalcedonic cement. These, or at least some of them, are the polymorph sandstone of the Congo Geological map.

This sandstone takes on the following aspects:

- a) A continuous layer, generally on the surface or near the surface of the soil. When resting on soft sandstone or when interbedded, this layer is apparently its superficial silification. It is considered as analogous to the «silcretes» of the Kalahari Desert.
- b) Disseminated areas in the mass of soft sandstone where it must

be considered as local silification.

d) Rolled blocks sometimes of enormous dimensions polished and patined as by desert phenomena.

4°) Humus bearing sands.

5°) Brownish silts or clay-bearing medium grained sandsewith locally lateritic gravel or mottled clay in process of lateritisation.

6°) Gravel of well rounded pebbles of hyaline, milky-white or pink quartz, of agate and silicified oolithes. They are mixed with debris of the polymorph sandstone, mentioned under 3rd c and d.

7°) Coarse sand with grains varying from 0 to 5 mm in diameter, containing heavy minerals (kyanite, staurolite, andalusite, etc.).

8°) Fine sand, not very well sorted, often white.

9°) White, clay very fine, plastic.

These formations are those of the Leopoldville plain; the surrounding hills are built of unstratified red, brown or grey sand.

While the attached map shows the distribution of these different formations, the following remarks should be taken into account:

We consider the Leopoldville plain as a replica of the actual Stanley Pool, where one can find islands between which meander fossil channels of the river. Succession in the islands is complete: from the red Inkisi sandstone, through the soft sandstone (with sometimes the fossil-bearing argilite at the base) to the chalcedonic sandstone in place or in rolled blocks, the whole succession covered with silt or sand, with laterite.

At the bottom of the deepest channels, the coarse sand and the gravel (N° 6), rest directly on the Inkisi sandstone, and are covered with white clay.

On the channel banks the characteristic succession of islands is interrupted by gully formation, and is continued by gravel and coarse sand.

The Leopoldville plain is far from being uniformly level: Walking through the town, along the Boulevard Albert, and starting from the railway station, there is a climb from the Regina Hotel to the Colectric Building, where a descent begins leading to the Galiema Bay.

A look from the Clinic (point 1), the highest point in town, in the direction of the Military Camp, shows that the Boulevard occupies a long depression between these two sites.

This depression corresponds to one of the fossil river channels that would have flowed into the Galiema Bay. The hills on which the Hospital and the Military Camp are built, are two « islands » rising above the fossil bed, and they show the stratigraphy described above.

Building contractors have noticed that foundations must be adapted to the different sites of the township. Sometimes their excavations struck a very hard stone layer nearly on the surface of the soil; at other times, very deep borings have only brought forth waterlogged sand.

The study of the subsoil by bore-holes and field observations have enabled the Geological Service to explain these particularities of the deep layers as well as for superficial deposits. On the other hand, a few anomalies have not yet been made clear.

CLIFF OF KALINA (Point 2)

This is the only spot of the river bank not yet hidden by buildings. It is an abrupt cliff with a very narrow and quite dangerous footpath half-way up, not meant for large groups. It can be reached by a flight of stairs cut into the rock, starting from the Governor General's private gardens.

Figure 1.

The cut shows the following succession, up from the river level to the lawns.

- I. Soft sandstone, greyish, massive.
- II. Polymorph sandstone.
- III. Locally, soft sandstone, brown to pink, with pink or undulating red zonation, but without visible stratification.
- IV. Gravel with quartz pebbles, agate, oolithe and polished and patinated blocks of polymorph sandstone, all of it mixed with coarse sand.
- V. Lateritic gravel.
- VI. Silt.

REMARKS

- a) There is no proof yet that the two « soft sandstones » above and under the polymorph sandstone, are one and the same formation.
- b) The origin of the polished and patinated polymorph sandstone blocks is unknown; is it a second layer not yet found in place, or are they remains of an uplift more to the south of the present layer in the cut?
- c) Around Leopoldville, in a radius of more than 100 kilometers, formations containing such coarse sand, a similar conglomerate, or agate bearing rocks, are unknown.

On the other hand, the gravel of Leopoldville has some similarity to the diamantiferous gravel of the Kasai. Part of the footpath runs on the polymorph sandstone. Further on, the gravel can be seen joining the polymorph sandstone along a sloping surface, dug into the superior soft sandstone, which is completely eroded at some twelve meters downstream from the stairs.

A rest bench is within 15 meters of the place where the gravel layer dips into the layer of polymorph sandstone to reappear 50 meters further. Between those two points there is only silt: the superior sandstone, the polymorph sandstone and a good part of the soft inferior sandstone have been removed by erosion. It is probably one of the channels that flowed into the river outside of the Galiema Bay.

The lateritic gravel has disappeared too, it becomes visible again above the gravel on the downstream slope of the channel, together with the polymorph sandstone layer and the inferior soft sandstone.

The gravel is continuous in the cut: it is always spread out over the polymorph sandstone, where, from time to time, remains of the soft superior sandstone are visible.

At the third flight of stairs, the footpath goes down under the polymorph sandstone, reduced here to a thickness of about 0,30 m. The path is cut in the soft inferior sandstone, which enables us to see the big difference between the two soft sandstone layers. This one is white, much more homogeneous and compact, cross bedded and cut by diaclasses.

At this place, on the polymorph sandstone flag, a remnant of the soft superior sandstone shows a beginning of lateritisation inside the rock. This means that there might be two levels of lateritisation of different ages, the one on the gravel being the oldest.

Three steps further down and a few meters away gravel and polymorph sandstone disappear. We find them back again at the end of the course, in the form of fallen blocks and in place, in exaggerated and unexpected thickness at the point where a stair goes up again towards the lawn.

In summary, Kalina's cliffs reveal :

- 1) A silicification level, that shows a change of environmental conditions after the emersion of the soft sandstone.
- 2) Continental conditions characterized by a heavy erosion and by a violent water flow able to move huge boulders.
- 3) New climatic conditions allowing lateritisation.
- 4) An immersion period characterized by the deposit of silt.
- 5) A present day period, with its own characteristics of erosion and lateritisation.

TRENCH CABU

(Point 3)

This trench was dug for the drainage of the entire native city of Leopoldville. It has proved insufficient for that purpose and now the Public Works Department of the town are executing a vast general drainage programme of the Lemba plain. The trench itself will be lengthened, enlarged and straightened. As it is now, it allows some very interesting observations. A section from the Avenue Baudouin bridge up to the confluent with another trench coming from the South, on a stretch of about 200 meters, shows the following :

Fig. 2

On a height of about 4 meters, the excavations have exposed medium sized white clayey sand with polymorph sandstone in the bed of the trench. No stratification can be seen; the polymorph sandstone appears as disjointed blocks.

This sand shows brownish zonation in the form of interrupted sub-horizontal bandings, inter-spaced and irregular.

One meter above the bottom of the trench appears brownish-red mottlings which continue and intensify up to 2.50 to 3 meters, where lateritic gravel can be observed, continuing downstream, parallel to the bottom of the trench (« mottled clay »).

Above the laterite was a layer of silt, now taken away by the rectification work. Therefore, one cannot see clearly the silt-gravel relationship. Moreover, the excavated material of the trench is spread out over the surface.

90 meters downstream from the bridge, a thin layer of gravel and coarse sand can be seen under the blocks of polymorph sandstone. Moreover, this ensemble is rising rapidly and the gravel is seen resting on a yellowish-white compact sandstone, cross-bedded, with diaclasses, and in every way comparable to the soft inferior sandstone of Kalina.

This shows that we have crossed a channel, filled up with clayey sand which is spread out over the soft sandstone downstream from the bridge.

At about 200 meters from the bridge, at the junction of the Cabu and the Southern trenches, chaotic lumps of brownish-black sand can be seen, remnants of an old dried-up swamp.

The general study of borings enabled one to observe that this humiferous sand rests on coarse aquiferous sand of the channels: this means that it is probably the indication of the passage of another channel.

In summary, this cut presents a certain analogy with the Kalina cliffs, except for the filling up of the channel by a new substance: white clayey sand, without silt, in process of lateritisation.

Now, borings on the Kalina plateau have shown that the silt overlays a mottled kaolin-bearing sand (in process of lateritisation) and polymorph sandstone. This seems to demonstrate the analogy of the cuts, and to establish the origin of the lateritic material above the gravel, which can therefore be colluvial at the Kalina cliffs.

MOUNT LEOPOLD (Point 4)

From Mount Leopold there is a splendid view of the whole of Leopoldville.

One can distinguish the Stanley Pool and Bamu Island, and in the background, more to the left, the Bateke plateau. In clear weather,

one can see at the foot of the plateau, the cliffs of white sand, which Stanley named the «Dover Cliffs». To the left, at our feet, is the Brazzaville plateau.

In clear weather, one can distinguish the outlet of the River Channel beyond Bamu Island.

Leopoldville shows up well the Kalina plateau (counterpart of the Brazzaville plateau), and the hill of the Military Camp. Between the two lies the Gombe Valley which follows an ancient river channel (mentioned in Point 1).

This channel empties into the Galiema Bay which lies at our feet.

Right in the background, in clear weather, one can conjecture the Kwango buttresses with the cliffs of red sand; a little ahead, the Mense Peak and its white cliffs. This peak is an outpost of the Kwango.

Lastly, to the right, the circle is closed by the buttresses of the Binza and Kimwenza plateaux.

THE GREAT CORNICHE

From the Western extremity of Mount Leopold — «the plateau of the hundred» — there is a good view over the Kinsuka rapids, (these rapids flow on the red sandstone of the Inkisi).

Coming down the road of the great Corniche one can see, near the bottom, the base gravel of the silt, overlaying the Inkisi sandstone.

This gravel is homologous to that of the level 1 at Kalina.

Geological Service.

July 1954.





Si Léopoldville est exempt d'insectes transmetteurs de maladies tropicales, c'est grâce aux campagnes de désinsectisations menées par avions et hélicoptères.

It is thanks to anti-insect campaigns made by planes and helicopters that Leo is free of insect bearing tropical diseases.



Aperçu général sur le Congo Belge

Le Congo Belge se situe au cœur du continent africain entre 5° 20' de latitude nord et 13° 28' de latitude sud d'une part, 12° 10' et 31° 15' de longitude est, d'autre part. La plus grande distance entre les frontières extrêmes se chiffre par 2000 km environ. La superficie de la Colonie s'élève à 2.344.000 km².

Le territoire de la Colonie se partage entre deux fuseaux horaires. Les provinces de Léopoldville et de l'Equateur se rattachent au 15° méridien est de Greenwich (fuseau horaire central : heure belge) ; la Province Orientale, le Kivu, le Kasai et le Katanga dépendent du 30° méridien est de Greenwich (fuseau horaire oriental : une heure en avance sur l'heure belge).

Topographie.

La « cuvette centrale » est d'une altitude moyenne de 400 mètres. Le pays est entouré d'une « ceinture de montagnes » ; à l'ouest, s'élèvent les monts de Cristal (maximum 1.050 m) qui longent la côte atlantique ; au sud les plateaux de Lunda et de Samba ; au sud-est, le massif du Katanga ; à l'est, deux chaînes de hautes montagnes, longues de 1.400 km, distantes l'une de l'autre de 40 km. Elles sont séparées par le grand Graben dans lequel se logent les lacs Tanganyika, Kivu, Edouard et Albert. Au nord, enfin, une crête sépare le bassin du Congo de celui du Nil.

Climat.

Dans les régions les plus chaudes (autour de l'Equateur), la température atteint une moyenne annuelle de plus de 25° (climat tropical à forte pluviosité). Dans les régions plus élevées, surtout dans la partie est du pays, la température moyenne est inférieure à 20° (climat tempéré). Dans le sud du pays (Katanga), la température est également influencée par l'altitude. Dans les régions situées sous l'Equateur, la moyenne des précipitations annuelles atteint un minimum de 1.500 mm et dépasse souvent 2000 mm.

Population.

Au 1^{er} janvier 1954, la population totale du Congo Belge était de 12 millions d'habitants.

D'après les plus récentes enquêtes, l'accroissement naturel de la population du Congo Belge serait de 6,66 pour mille, soit 70.000 personnes par an (naissances : 31,48 pour mille ; décès : 24,82 pour mille).

Pour le Congo, la densité moyenne est de 5,03 habitants par km².

Environ 80 p. c. (9,3 millions d'habitants) de la population indigène vit encore dans la brousse (dans les centres coutumiers), tandis que les 20 p. c. restants (2,4 millions d'habitants) se groupent autour des villes ou des centres industriels.

GENERAL SUMMARY OF THE BELGIAN CONGO

The Belgian Congo is situated in the heart of the African continent between 5° 20' north latitude and 13° 28' south latitude on the one hand, and 12° 10' and 31° 15' east longitude on the other. The greatest distance between frontiers is about 2,000 kilometers. The Colony covers an area of 2,344,000 square kilometers.

The territory of the colony has two time-belts. The Leopoldville and Equator Provinces are connected with the Greenwich 15th. east meridian (central time-belt ; Belgian time) ; The Eastern, Kivu, Kasai and Katanga Provinces depend on the Greenwich 30th. east meridian (eastern time-belt : one hour ahead of that of Belgium).

TOPOGRAPHY

The « central basin » is of an average altitude of 400 meters. The country is surrounded by a « belt of mountains » ; to the west are the Cristal Mountains (maximum 1,050 m.) which hug the Atlantic coast ; to the south are the Lunda and Samba plateaux ; to the south-east, the Katanga mountain mass ; to the east, 2 chains of high mountains 1,400 kms. long, with a distance from one to the other of 40 kms. They are separated by the great Graben in which are found the Tanganyika, Kivu, Edward and Albert Lakes. Finally, to the north, a crest separates the Congo Basin from that of the Nile.

CLIMATE

In the hottest regions (around the Equator), the temperature reaches an annual average of more than 25° (tropical climate with heavy rainfall). In higher altitude regions, particularly in the eastern part of the country, the average temperature is less than 20° (temperate climate). In the south of the country (Katanga) the temperature is also influenced by the altitude. In regions situated on the Equator, the annual average rainfall reaches a minimum of 1,500 mm. and often exceeds 2,000 mm.

POPULATION

On January 1st. 1954 the total population of the Belgian Congo was 12 million inhabitants. According to recent investigations made, the natural increase of the Belgian Congo population would be 6,66 in a 1,000 or 70,000 persons a year (births) ; (31,48 for 1,000 — 24,82 for a thousand deaths).

The average density in the Congo is 5,03 inhabitants per square kilometre.

About 80% of the native population (9,3 millions of the inhabitants) still live in the bush (in customary centres) whereas the remaining 20 % (2,4 million of inhabitants) are grouped around towns or industrial centres.

**Organisation Administrative du Congo
et du Ruanda-Urundi**

*Administration of the Belgian Congo
and of Ruanda-Urundi*

Provinces	Chefs-lieux	Districts	Territoires
<i>Provinces</i>	<i>Chief-towns</i>	<i>Districts</i>	<i>Extents of jurisdiction</i>
Léopoldville	Léopoldville	4	23
Province Equateur	Coquilhatville	3	23
Province Orientale	Stanleyville	3	23
Kivu	Bukavu	3	18
Katanga	Elisabethville	4	24
Kasaï	Luluabourg	3	21
Total		20	133
Ruanda-Urundi	Usumbura	2	18



SIGLES — ABBREVIATIONS OF TITLES

AEF	Afrique Equatoriale Française <i>French Equatorial Africa</i>
AOF	Afrique Occidentale Française <i>French West Africa</i>
AMI	Agence Maritime Internationale , Place de la Poste, Léopoldville <i>(International Shipping Agency)</i>
BBA	Banque Belge d'Afrique , 19, avenue Ministre Rubbens, Léopoldville
BCB	Banque du Congo Belge , avenue Hauzeur, Léopoldville
BNCI	Banque Nationale pour le Commerce et l'Industrie , Angle des Avenues Beernaert et Reine Astrid.
BIS	Bureau Interafricain des Sols , 57, rue Cuvier, Paris <i>Interafrican Soils Office</i>
CCTA	Commission pour la Coopération Technique en Afrique au Sud du Sahara , 43, Parliament Street, London S. W. 1 <i>Technical Cooperation Committee in Africa, South of the Sahara.</i>
CNKi	Comité National du Kivu <i>Kivu National Committee</i>
C.R.A.C.C.U.S.	Comité Régional de l'Afrique Central pour l'Utilisation et la Conservation du Sol. <i>Central African Regional Committee for the Conservation and Utilisation of Soil.</i>
C.R.O.A.C.U.S.	Comité Régional de l'Ouest Africain pour la Conservation et l'Utilisation du Sol. <i>West African Regional Committee for the Conservation and Utilisation of Soil.</i>
CSA	Conseil Scientifique pour l'Afrique au Sud du Sahara , Boîte Postale 5175, Bukavu, Congo Belge <i>Scientific Council for Africa, South of the Sahara</i>
CSK	Comité Spécial du Katanga <i>Katanga Special Committee</i>

EAHC	East African High Commission , P. O. Box 601, Nairobi, Kenya <i>Haut Commissariat pour l'Est de l'Afrique</i>
EAA	Ecole d'Assistants Agricoles <i>School for Agricultural Assistants</i>
EPA	Ecole Professionnelle d'Agriculture <i>Agricultural Professional School</i>
FAO	Food and Agricultural Organisation , Via delle Terme di Caracalla, Rome <i>Organisation des Nations Unies pour l'Alimentation et l'Agriculture (voir OAA)</i>
FBI	Fonds du Bien-Etre Indigène , 3, rue Montoyer, Bruxelles <i>Native Welfare Fund</i>
IBED	Inter-African Bureau of Epizootic Diseases , P. O. Box 21, Kikuyu, Kenya <i>Bureau Inter-Africaine des Maladies Epizootiques</i>
IECA	Institut d'Etudes Centrafricaines , B. P. 181, Brazzaville <i>Central African Study Center</i>
IGCB	Institut Géographique du Congo Belge , boulevard Albert I ^{er} , Léopoldville <i>Geographical Institute of the Belgian Congo</i>
ILO	International Labour Organisation , 205, boulevard Saint- Germain, Paris 7 ^e <i>Organisation Internationale du Travail (voir OIT)</i>
INEAC	Institut National des Etudes Agronomiques au Congo , 12-14, rue aux Laines, Bruxelles, et Yangambi, Congo Belge <i>National Institute for Agricultural Studies in the Belgian Congo</i>
INFAN	Institut Français d'Afrique Noire , B. P. 206, Dakar <i>French Institute of Black Africa</i>
IPNCB	Institut des Parcs Nationaux du Congo Belge , 41, rue Mon- toyer, Bruxelles <i>Belgian Congo National Parks</i>
IRCB	Institut Royal Colonial Belge , 25, avenue Marnix, Bruxelles <i>Belgian Colonial Royal Institute</i>

- IRSAC **Institut pour la Recherche Scientifique en Afrique Centrale.**
Bukavu, Congo Belge
Institute of Scientific Research in Central Africa.
- OAA **Organisation des Nations Unies pour l'Alimentation et l'Agriculture**
Food and Agricultural Organization (voir FAO)
- OIT **Organisation Internationale du Travail**
International Labour Organization (voir ILO)
- ORSTOM **Office de la Recherche Scientifique et Technique d'Outre-Mer.**
Office of Scientific Research (Overseas)
- PNA **Parc National Albert**
- PNG **Parc National de la Garamba**
- PNK **Parc National de la Kagera**
- PNU **Parc National de l'Upemba**
- S.A.R.C.C.U.S. **South African Regional Committee for the Conservation and Utilisation of Soil.**
Comité Régional de l'Afrique du Sud pour la Conservation et l'Utilisation du Sol.
- SPI **Service Pédologique Inter-Africain, Yangambi, P. S. Congo Belge**
Interafrican Pedological Service
- UIPN **Union Internationale pour la Protection de la Nature, 42, rue Montoyer, Bruxelles**
International Union of Nature Protection
- UNESCO **United Nations Educational Scientific and Cultural Organization, Unesco House, 19, avenue Kléber, Paris 16°**
Organisation pour la Science et la Culture des Nations-Unies.

Jours et heures de départ <i>Days and hours of departure</i>		Companies Compagnies	Departure from Départ de	For Pour	Via Via
Lundi	11 h. 30	Monday	Air-France	Paris	Douala
Lundi	14 h. 45	Monday	Sabena	Bruxelles (*)	Kano Tripoli
Mardi	14 h. 45	Tuesday	Sabena	Bruxelles (*)	Kano-Tripoli
Mardi	11 h. 30	Tuesday	Air-France	Paris	Bangui
Mardi	15 h. 45	Tuesday	U.A.T.	Paris	Tripoli
Mardi	13 h. 30	Tuesday	K.L.M.	Amsterdam	Rome
Mercredi	16 h. 45	Wednesday	P.A.A.	New-York	Lisbonne
Mercredi	13 h. 00	Wednesday	U.A.T.	Paris	Libreville
Mercredi	13 h. 00	Wednesday	Sabena	Bruxelles (*)	Kano-Rome
Mercredi	15 h. 15	Wednesday	Sabena	Bruxelles (*)	Kano-Genève
Jeudi	14 h. 45	Thursday	U.A.T.	Paris	Bangui
Jeudi	14 h. 45	Thursday	Sabena	Bruxelles (*)	Kano-Casa
Jeudi	7 h. 00	Thursday	Sabena	Johannesbourg	Elisabethville
Jeudi	13 h. 00	Thursday	Sabena	Bruxelles (*)	Entebbe
Jeudi	9 h. 00	Thursday	Sabena	Bruxelles (*)	Entebbe
Vendredi	10 h. 30	Friday	Air-France	Paris	Pointe-Noire
Vendredi	14 h. 45	Friday	Sabena	Bruxelles (*)	Kano-Lisbonne
Vendredi	13 h. 00	Friday	Sabena	Bruxelles (*)	Kano-Tripoli
Samedi	14 h. 45	Saturday	Sabena	Bruxelles (*)	Kano-Rome
Dimanche	16 h. 45	Sunday	P.A.A.	New-York	Lisbonne
Dimanche	14 h. 45	Sunday	Sabena	Bruxelles (*)	Kano-Rome
Dimanche	13 h. 00	Sunday	Sabena	Bruxelles (*)	Entebbe
Dimanche	9 h. 00	Sunday	Sabena	Bruxelles (*)	Entebbe
Dimanche	7 h. 00	Sunday	Sabena	Nairobi	

(*) Donne correspondance pour Londres et New-York.



Stade de Léopoldville — *Leopoldville's stadium.*

AGENDA

Dimanche 8 août :

Sunday, August 8th :

- de 9 h. 30 — Fête Nautique sur le Fleuve Congo à bord du m/b « Général Olsen ».
à 17 h. —
from 9.30 a.m. — Nautical Feast on the Congo River on board the m/m « Général Olsen ».
to 6 p.m. —

Lundi 9 août :

Monday, August 9th :

- 10 h. — Séance inaugurale de la Conférence Inter africaine des Sols (C.C.T.A.) — (Salle des Conférences de l'Institut de Médecine Tropicale « Princesse Astrid »).
17 h. 15 — Visite des Usines UTEXLEO.
17 h. 15 — Visite d'une Ecole Professionnelle et de l'Ecole d'Art St. Luc.
17 h. 15 — Séance de cinéma (films réalisés au Congo) au Service de l'Information — Programme A.
20 h. 30 — Salle Albert 1er — Conférence de Pierre Nord.
10 a.m. — Inaugural Session of the Inter african Soils Conference (C.C.T.A.) — (Conference Hall of the Institute of Tropical Medicine « Princesse Astrid »).
5.15 p.m. — Visit to the UTEXLEO factory.
5.15 p.m. — Visit to a Vocational School and to the St. Luc School.
5.15 p.m. — Cinema (films turned in the Congo) at the Information Service — Programme A.
8.30 p.m. — Albert 1st Hall — Lecture by Pierre Nord.

Mardi 10 août :

Tuesday, August 10th :

- 17 h. 15 — Conférence Inter africaine des Sols.
17 h. 15 — Visite d'une Ecole Professionnelle et de l'Ecole d'Art St. Luc.
17 h. 15 — Visite du Musée de Préhistoire.
17 h. 15 — Visite du Musée de Géologie (Commentaires en français).

Inter african Soils Conference.
5.15 p.m. — Visit to a Vocational School and to the St. Luc Art School.
5.15 p.m. — Visit to the Prehistoric Museum.
5.15 p.m. — Visit to the Museum of Geology (Commentaries in French).
-

Mercredi 11 août :

Wednesday, August 11th :

- 17 h. 15 — Conférence Inter africaine des Sols.
17 h. 15 — Visite du Laboratoire des Travaux Publics.
17 h. 15 — Visite du Jardin Zoologique.

Inter african Soils Conference.
5.15 p.m. — Visit to the Public Works Department Laboratories.
5.15 p.m. — Visit to the Zoological Garden.
-

Jeudi 12 août :

Thursday, August 12th :

- Après-midi — Conférence Inter africaine des Sols.
Excursion à Brazzaville (départ à 13 h. 30, retour vers 18 h.).

Inter african Soils Conference.

Afternoon — Excursion to Brazzaville. (Departure 13.30 h. — Return-About 6 p.m.).
-

Vendredi 13 août :

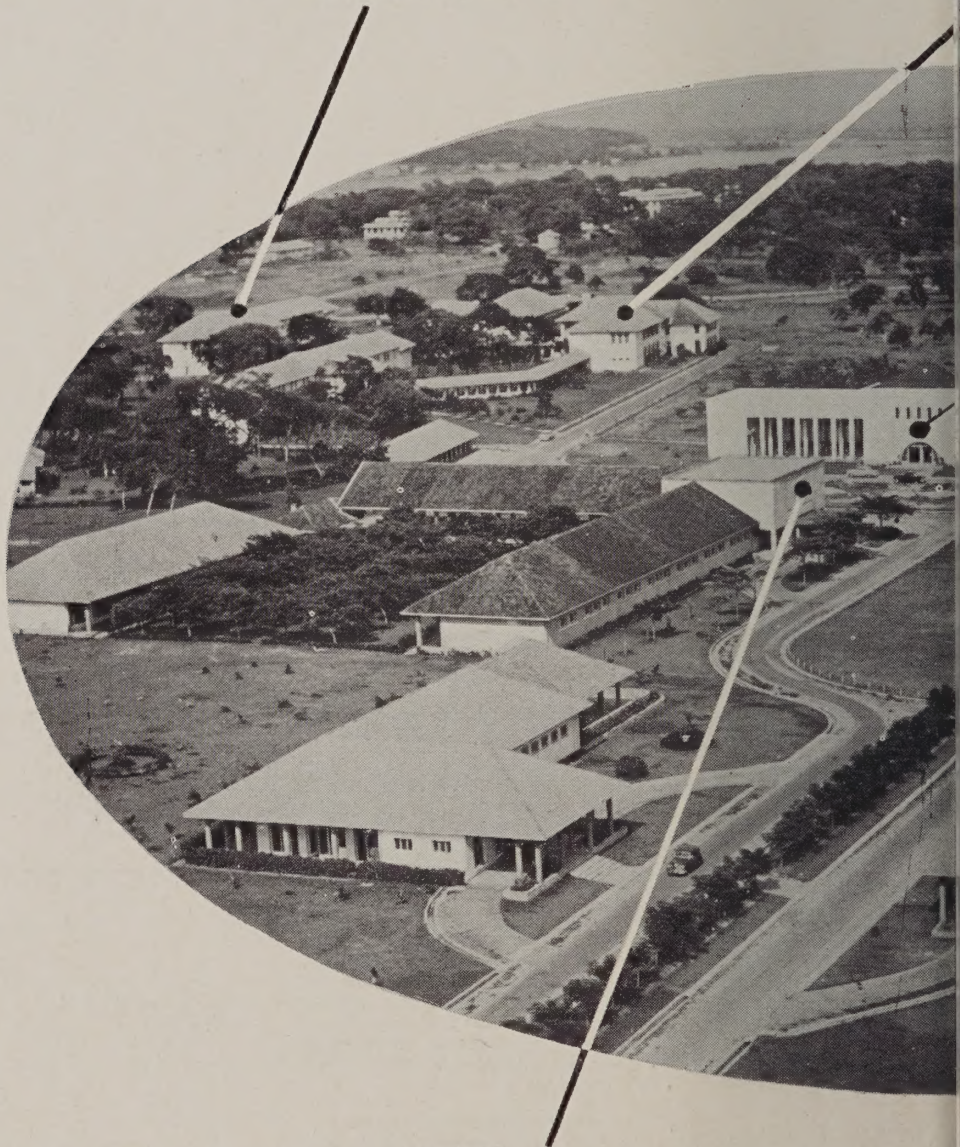
Friday, August 13th :

- 17 h. 15 — Conférence Inter africaine des Sols.
17 h. 15 — Visite du Musée de Préhistoire.
17 h. 15 — Visite du Musée de Géologie (commentaires en anglais).
17 h. 15 — Visite de l'Institut Géographique du Congo Belge.
20 h. — Visite du Musée de la Vie Indigène.
20 h. — Séance de Cinéma (films réalisés au Congo) au Service de l'Information — Programme B.

Inter african Soils Conference.
5.15 p.m. — Visit to the Prehistoric Museum.
5.15 p.m. — Visit to the Geology Museum (commentaries in English).
5.15 p.m. — Visit to the Geographical Institute of the Belgian Congo.
9 p.m. — Visit to the Museum of Native Life.
9 p.m. — Cinema Session (films turned in the Congo) at the Information Service — Programme B.

Locaux réservés aux Assises de la Conférence Inter africaine des
Meeting rooms for the Inter african Soil Conference and

- Logement
- Accomodation



ACCUEIL

Renseignements, courrier, banque change, poste, télégraphe, agence de voyage, trésorerie, librairie, assurance.

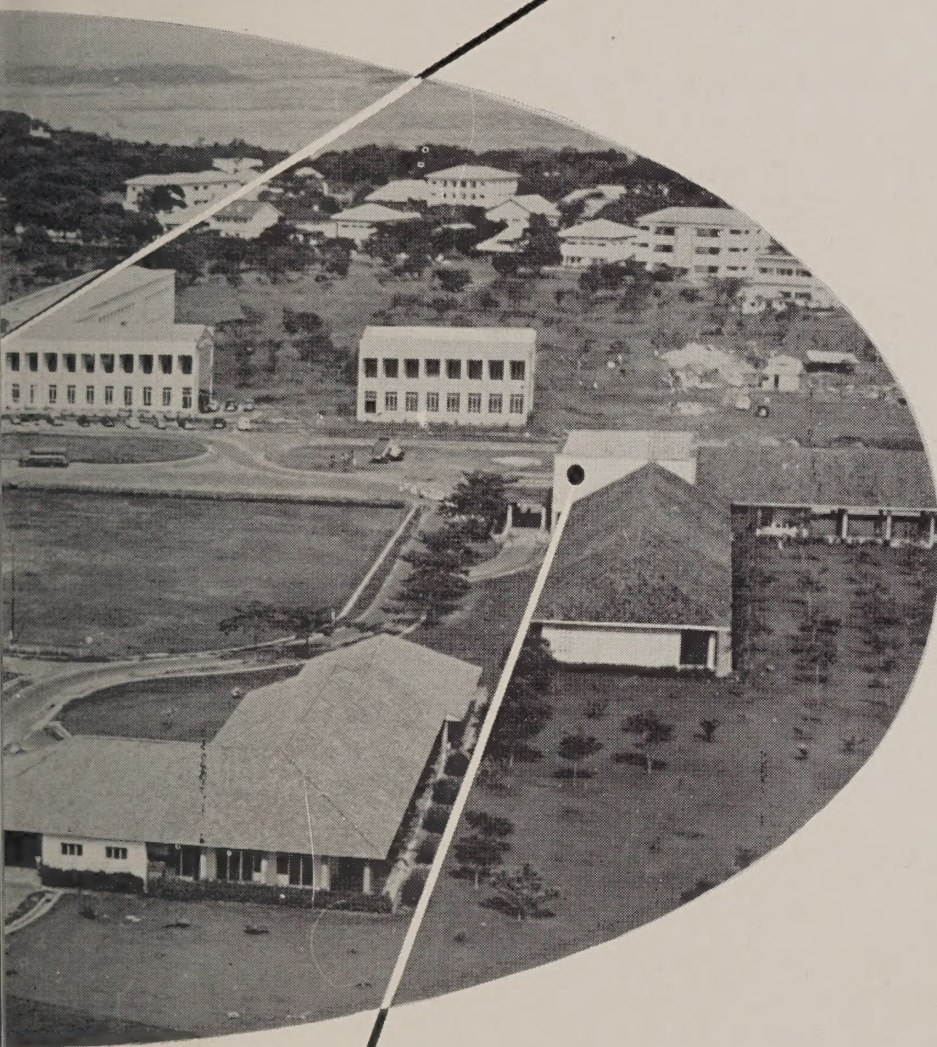
RECEPTION

Information, Post Office, Exchange, Telegraph, Travelling Agency, Treasury.

Sols et du Congrès International de la Science du Sol for the Fifth International Congress of Soil Science

— Restaurant
— Dispensaire
Dispensary

— Salle des Commissions
Commission rooms
— Bureau de la S.I.S.S.
I.S.S.S. Office



Secrétariat Général ; Bureau des Interprètes, des Secrétaires de commissions, des Traducteurs ; Conférences générales.

General Secretary's Office ; Interpreters' Office of Commissions Secretary's Office, Translators' Office ; General Lectures.

Samedi 14 août :**Saturday, August 14th :**

- 13 h. — Conférence Interafricaine des Sols.
 Au « Galiéma » déjeuner de clôture de la Conférence Interafricaine des Sols.
- 21 h. — Grand Bal annuel de la Croix-Rouge dans les nouveaux jardins de la Résidence du Gouverneur Général. (Tenue de soirée).
- 1 p.m. — Interafrican Soils Conference.
 Luncheon at the « Galiéma » for the closing of the Interafrican Soils Conference.
- 9 p.m. — Grand Annual Ball of the Red Cross in the new gardens of the Governor General's Residence. (Black tie).

Dimanche 15 août :**Sunday, August 15th :**

- de 9 h. — Exposition maraîchère et artisanale au Parc De Bock. (Possibilités à 11 h. d'achats de nombreux souvenirs d'art indigène).
- 11 h. 30 — Réception des congressistes à l'Hôtel de Ville.
- 16 h. 45 — Stade Roi Baudouin : Match de football.
- 20 h. — A l'Hôtel Regina : Danseur Africain Alexis TSHIBANGU.
- from 9 a.m. — Vegetable, Flower and and Handicrafts Exhibition at the Parc De Bock. (Possibilities of buying numerous souvenirs of native handicrafts).
- 11.30 a.m. — Reception of Congress Members at the Town Hall.
- 4.45 p.m. — King Baudouin Stadium : Football match.
- 9 p.m. — At the Regina Hotel : Alexis TSHIBANGU — African dancer.

Lundi 16 août :**Monday, August 16th :**

- 10 h. — Séance d'ouverture du Vème Congrès International de la Science du Sol. (Salle Albert 1er).
- 11 h. — Assemblée générale de la Société Internationale de la Science des Sols.
- 17 h. 30 — Garden Party offerte par Monsieur le Gouverneur Général aux congressistes. (Tenue de ville).
- 10 a.m. — Opening Session of the Fifth International Congress of Soil Science. (Albert 1st Hall).
- 11 a.m. — General Assembly of the International Society of Soil Science.
- 5.30 p.m. — Garden Party given by the Governor General for Congress Members. (Lounge suit).

Mardi 17 août :**Tuesday, August 17th :**

- 16 h. 45 — Congrès International de la Science du Sol.
 Match Football Int. Stade Roi Baudouin.
- 17 h. 15 — Visite du Musée de Préhistoire.
- 17 h. 15 — Visite de l'Institut Géographique du Congo Belge.
- 17 h. 15 — Visite de l'Ecole d'Art St. Luc.
- 17 h. 15 — Visite de l'Usine UTEXLEO.
- 20 h. — Visite du Musée de la Vie Indigène.
- 20 h. — Séance de cinéma (films réalisés au Congo) au Service de l'Information — Programme A.
- International Congress of Soil Science.
- 4.45 p.m. — Football Matches at the King Baudouin Stadium.
- 5.15 p.m. — Visit to the Prehistoric Museum.
- 5.15 p.m. — Visit to the Belgian Congo Geographic Institute.
- 5.15 p.m. — Visit to the St. Luc Art School.
- 5.15 p.m. — Visit to the UTEXLEO factory.
- 8 p.m. — Visit to the Museum of Native Life.
- 8 p.m. — Cinema Session (films turned in the Congo) at the Information Service — Programme A.

Mercredi 18 août :**Wednesday, August 18th :**

- Congrès International de la Science du Sol.
17 h. 15 — Visite du Musée de Préhistoire.
17 h. 15 — Visite du Musée de Géologie (commentaires en français).
17 h. 15 — Visite du Laboratoire des Travaux Publics.
17 h. 15 — Visite du Jardin Zoologique.

International Congress of Soil Science.
5.15 p.m. — Visit to the Prehistoric Museum.
5.15 p.m. — Visit to the Museum of Geology (commentaries in French).
5.15 p.m. — Visit to the Public Works Department Laboratory.
5.15 p.m. — Visit to the Zoological Garden.
-

Jeudi 19 août :**Thursday, August 19th :**

- Congrès International de la Science du Sol.
14 h. — Excursion géologique.
18 h. — Visite de la Brasserie de Léopoldville.

International Congress of Soil Science.
2 p.m. — Geological Excursion.
6 p.m. — Visit to the Leopoldville Brewery.
-

Vendredi 20 août :**Friday, August 20th :**

- Congrès International de la Science du Sol.
17 h. 15 — Visite du Musée de Géologie (commentaires en anglais).
17 h. 15 — Visite de l'Ecole des chauffeurs de la Force Publique.
17 h. 15 — Séance de cinéma (films réalisés au Congo) au Service de l'Information — Programme B.
20 h. — Visite du Musée de la Vie Indigène.
20 h. — Cercle Hippique : Attribution de la coupe Congrès de la Science du Sol.

International Congress of Soil Science.
5.15 p.m. — Visit to the Museum of Geology (commentaries in English).
5.15 p.m. — Visit to the Drivers' School of the Force Publique.
5.15 p.m. — Cinema Session (films turned in the Congo) at the Information Service — Programme B.
8 p.m. — Visit to the Museum of Native Life.
8 p.m. — Cercle Hippique : Competition for the Cup of the Congress of Soil Science.
-

Samedi 21 août :**Sunday, August 21st :**

- Congrès International de la Science du Sol.
17 h. — Assemblée générale de la Société Internationale de la Science du Sol.
21 h. — Séance de danses congolaises organisée au Parc De Bock en l'honneur des congressistes.

International Congress of Soil Science.
5 p.m. — General Assembly of the International Society of Soil Science.
9 p.m. — Congolese dances organised in the Parc De Bock in honour of Congress Members.



Dimanche 22 août :

Sunday, August 22nd :

Excursion sur le Pool et à Brazzaville, offerte aux congressistes (départ à 10 h., retour vers 18 h.).

Excursion on the Pool and to Brazzaville offered to Congress Members. (departure at 10 a.m. — return at about 6 p.m.).

Lundi 23 août :

Monday, August 23rd :

Excursion dans le Bas-Congo (M'Vuazi — Matadi).

Excursion in the Lower-Congo (M'Vuazi — Matadi).

Mardi 24 août :

Tuesday, August 24th :

Excursion dans le Bas-Congo (Gimbi — Matadi).

Excursion in the Lower-Congo (Gimbi — Matadi).

Mercredi 25 août :

Wednesday, August 25th :

Excursion in the Lower-Congo — return to Leopoldville.

Excursion dans le Bas-Congo — Retour à Léopoldville.

Jeudi 26 août :

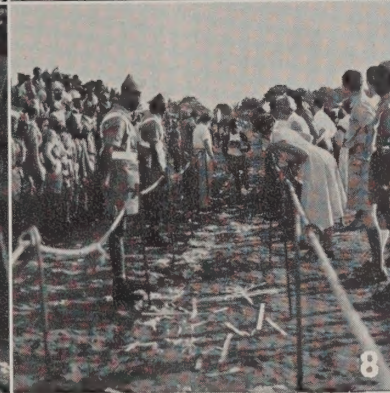
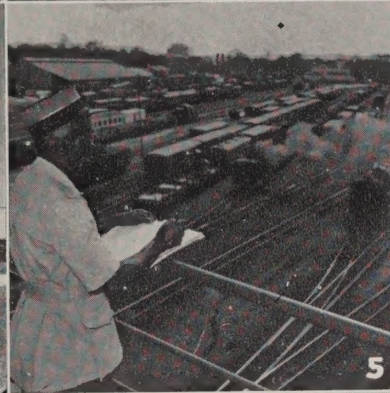
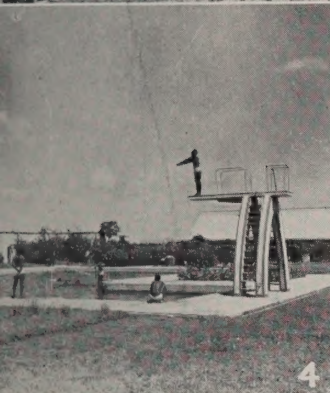
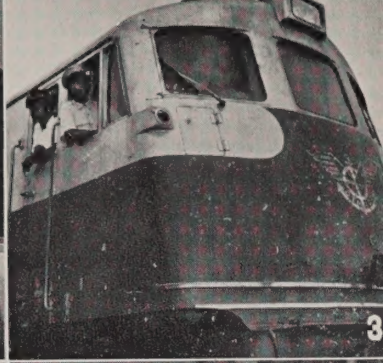
Thursday, August 26th :

Departure on the excursion to Yangambi.

Départ de l'excursion à Yangambi.

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La Vie à Léopoldville

1 à 9) Quelques aspects de la vie à Léopoldville.

A few scenes of life in Leopoldville.

10) Le monument Stanley.

The monument to Stanley.





②
V^e CONGRÈS INTERNATIONAL
DE LA SCIENCE DU SOL

Vth INTERNATIONAL CONGRESS
OF SOIL SCIENCE



PROGRAMME

LÉOPOLDVILLE

16/21 - VIII - 1954

V^e CONGRÈS INTERNATIONAL
DE LA SCIENCE DU SOL

Sous le Haut Patronage
de
Sa Majesté le Roi des Belges

LÉOPOLDVILLE - 16/21 août 1954

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Compagnie du Kasai (C. K.)

Union Minière du Haut Katanga (U.M.H.K.)

Compagnie du Congo pour le Commerce et l'Industrie
(C.C.C.I.)

Compagnie du Lomami et du Lualaba

Société Agricole et Commerciale de la Busira et du Haut-
Congo (S.A.B.)

Chantier Naval et Industriel du Congo (CHANIC)

Les Minoteries du Katanga

Compagnies Réunies des Huileries du Congo Belge et
Savonneries Lever Frères (HUILEVER)

Compagnie Chimique et Industrielle du Congo (CHI-
MINCO)

Comité National du Kivu (C.N.Ki.)

Société de Colonisation Agricole au Mayumbe (SCAM)

Compagnie Générale d'Automobiles et d'Aviation au Congo
(CEGEAC)

Société Coloniale d'Importation et d'Exportation (CO-
LIMPEX)

Société Africaine de Produits Chimiques et Industriels
(SAPCHIM)

MEMBRES PROTECTEURS — PROTECTING MEMBERS

Société BELGIKA
Société des Tabacs au Congo Belge (TABACONGO)
Compagnie Commerciale et Minière de l'Uélé (COMUELE)
Société Auxiliaire Agricole du Kivu (SAAK)
Compagnie Française de l'Afrique Occidentale (C.F.A.O.)
Compagnie Congolaise de l'Hévéa
Société Congolaise SHELL
Société des Mines d'Or de Kilo-Moto
Compagnie Agricole d'Afrique (C.A.D.A.)
Société Forestière et Commerciale du Congo Belge (FORESCOM)
Société Equatoriale Congolaise de la Lulonga et de l'Ikelemba (SECLI)
Société Forestière et Agricole du Mayumbe (AGRIFOR)
Compagnie des Produits et des Frigorifères du Congo (PROFRIGO)
Bamboli Cultuur Maatschappij
Société de Cultures au Congo Belge (SACCB)

MEMBRES ORDINAIRES — MEMBERS

Société d'Exploitation Forestière au Kasai (EXFORKA)
Compagnie Cotonnière Coloniale (COLOCOTON)
Société d'Agriculture et de Plantations au Congo (A.P.C.)
Société Congolaise d'Electricité et de Mécanique (SEMCONGO)
Société Générale Industrielle et Chimique du Katanga (SOGECHIM)
Compagnie Jules VAN LANCKER (J.V.L.)
Société des Plantations de Lukolela
Société Congolaise BUNGE
Compagnie des Chemins de Fer du Congo Supérieur aux Grands Lacs Africains
Compagnie de LINEA
Société des Plantations de Dembia (PLANTADEM)
Société des Plantations de Katombe au Katanga
Monsieur VISEZ, Administrateur-Délégué de la Brasserie de Léopoldville

Renseignements généraux

1. Le **Secrétariat Général** est installé dans les locaux de l'Athénée Royal. Il est ouvert de 7 h. 30 à 18 heures pendant toute la durée du Congrès et dès l'arrivée des participants. Une permanence sera assurée en dehors de ces heures d'ouverture.

De même, le *Bureau de réception* et le *Bureau du Trésorier* seront accessibles aux congressistes, dans les mêmes locaux, de 7 h. 30 à 17 heures. Tous renseignements pourront y être obtenus touchant les diverses manifestations organisées à l'occasion du Congrès.

Divers offices sont à la disposition des participants dans le Hall d'accueil :

- Une *Agence de change* de la Banque du Congo Belge ;
- Une *Agence de voyage* ;
- Un *Bureau des Postes, Télégraphes et Téléphones* ;
- Une *Agence d'Assurance* ;
- Une *Librairie et papeterie* ;
- Une infirmerie pourvue des médicaments usuels et notamment des antimalariques.

Des casiers portant le numéro d'inscription et le nom de chaque congressiste sont dressés dans le Hall d'accueil et sont destinés à recevoir tous les documents et communications ainsi que la correspondance personnelle. Les membres du Congrès sont priés de dégager régulièrement leur casier.

2. Repas.

Le déjeuner pourra être pris de 12 h. 30 à 13 h. 30 dans les locaux de l'Athénée (Réfectoire).

Le prix de ce repas est fixé à 60 francs. Le paiement s'en effectuera par des tickets qui devront être préalablement retirés au Bureau du Trésorier.

Un rafraîchissement, thé ou café, sera servi gracieusement aux congressistes durant les interruptions de séance, le matin et l'après-midi. Le café qui sera servi dans ces conditions a été fourni gracieusement au Congrès par l'Office du Café Robusta du Congo.

Le réfectoire de l'Athénée restera accessible pendant la soirée, mais aucun repas n'y sera servi. Toutefois, des rafraîchissements pourront y être obtenus.

3. Service d'autobus.

Un service régulier d'autobus fonctionne pendant la période du Congrès et assure, toutes les heures, la liaison entre la ville et les locaux de l'Athénée Royal où se tiennent les assises du Congrès.

4. Locaux et séances.

La séance inaugurale du Congrès se tiendra dans la Salle des Fêtes du Collège Albert I^{er}, à proximité de l'Athénée.

Les assemblées générales, les conférences générales et les réunions de Commission auront lieu dans diverses salles de l'Athénée, chacune d'elles portant une lettre indicative reprise à l'Agenda du Congrès.

Une salle de lecture est à la disposition des congressistes, dans les locaux du Secrétariat Général.

L'attention des participants est attirée sur le fait que l'horaire sera ponctuellement respecté.

5. Visites et excursions.

Pendant le Congrès, des visites ou sorties guidées de courte durée seront organisées à l'intention et au choix des participants. Le détail en figure dans l'Agenda ci-après. Les compléments ou modifications seront régulièrement portés à la connaissance des participants. En principe, toutes ces visites seront organisées au départ du Bureau de réception.

Tous renseignements utiles touchant les excursions prévues pendant et après le Congrès seront fournis en temps opportun aux membres régulièrement inscrits.

Les participants dûment inscrits aux excursions organisées après le Congrès peuvent dès à présent retenir leur fiche nominative au Bureau du Trésorier. Celle-ci sera exigée au départ de chaque excursion.

6. Publications.

Les deux premiers volumes des Transactions du Congrès sont distribués, en édition provisoire, aux membres présents. Un troisième volume sera édité ultérieurement.

Les auteurs de communications sont priés de confirmer au Secrétariat Général, le nombre de tirés à part désirés.

7. Assurances.

Le Comité d'Organisation du Congrès décline toute responsabilité en ce qui concerne les accidents corporels ou matériels pouvant survenir aux participants durant le Congrès ou les excursions.

Les Congressistes qui désireraient s'assurer contre ces risques s'adresseront utilement à l'agence d'assurances installée dans le Hall d'accueil.

General Information

1. The General Secretary's Office will operate in the « Athénée Royal » building. It will be open from 7.30 a.m. to 6 p.m. for the duration of the Congress, from the day of arrival of the participants.

An Officer of the Congress will be available at all other times.

The Information Desk and the Treasurer's Office will be open to the participants in the same building from 7.30 a.m. to 5.00 p.m. All particulars regarding the various functions organized during the Congress may be obtained from this Department.

The following facilities will also be available to the participants in the Reception Hall :

- Currency exchange office of the Banque du Congo Belge.
- Travel Agency.
- Post, Télégraph and Telephone Office.
- Insurance Office.
- Bookstore.
- First Aid Station, provided with the usual pharmaceutical products and particularly with anti-malarial drugs.

Members of the Congress are requested to collect their mail and Congress documents in the pigeon-holes set up for that purpose in the Reception Hall.

The pigeon-holes are identified by the registration number and name of the participant.

2. Meals.

Lunch will be served from 12.30 to 1.30 p.m. in the Refectory of the Athénée Royal.

The price of this meal is 60 francs.

Tickets for meals can be bought at the Treasurer's Office and payment for meals may only be effected by means of such tickets.

Free refreshments will be served to the participants during the intervals in the morning and in the afternoon.

Coffee will be served the members of the Congress by courtesy of the « Office du Café Robusta du Congo ».

The Refectory of the Athénée will remain open in the evening, but no meals will be served at that time. Refreshments, however, will be available.

3. Premises and Sessions.

The Congress Inaugural Session will be held in the Albert College near the Athénée.

General sessions, lectures and Commission meetings will be held in various rooms of the Athénée. Rooms are identified by letters corresponding to the indications given in the Congress Agenda.

A reading room is at the disposal of the participants in the rooms of the General Secretary's Office.

The attention of the participants is called to the fact that the schedule of meetings will be strictly adhered to.

4. Visits and Excursions.

During the Congress, members will have the choice of a number of short duration visits and excursions, with guides. Details appear on the draft agenda herewith. Additional information and notice of any changes will be given to members in due course. As a general rule, all these visits will start from the Reception Hall.

All necessary information relating to excursions organized during and after the Congress will be given in due course to members who have registered for such excursions.

Members who have registered for the excursions after the Congress, may collect their individual excursion card from the Treasurer's Office, straightaway. This card must be presented at the beginning of each excursion.

5. Coach for visits and excursions.

A special coach will be available for members taking part in the various visits and attending the functions organized for their benefit.

The coach will leave from the Athénée and, on its return, will call at the various hotels in town.

6. Publications.

A provisional edition of the two first volumes of Communications presented at the Congress will be distributed to the members present. A third volume will be published in due course.

Authors of Communications are requested to inform the Secretariat General of the number of reprints they wish to receive.

7. Insurances.

The Organizing Committee of the Congress cannot be held responsible for bodily injury or accidents to property incurred by the members during the Congress or the excursions.

Members wishing to take out an insurance against such risks may apply to the Insurance Office in the Reception Hall.

Agenda du Congrès

Congress Agenda

Dimanche 15 août
Sunday, August 15th

Réception des congressistes. Enregistrement et distribution des documents.

Reception of the congress participants. Enrolment and distribution of congress papers.

- 11 h. Réception des congressistes à l'Hôtel de Ville.
Reception of the Congress participants at the Town Hall.

Lundi 16 août
Monday, August 16th

- 8 h. 30 Réunion des Bureaux des Commissions.
Meeting of the sectional Officers.

- 10 h. *Salle du Collège Albert. — Albert College Hall.*
Séance d'ouverture. — Opening Session.

Ouverture officielle du Congrès par M. Léo Pétillon, Gouverneur Général du Congo.

Adresse présidentielle par M. F. Jurion.

Official opening by Mr Léo Pétillon, Governor General of Belgian Congo.

Presidential adress by Mr F. Jurion.

- 11 h. 15 *Salle du Collège Albert. — Albert College Hall.*
Réunion de la *Société Internationale de la Science du Sol.*

Meeting of the *International Soil Science Society.*

(Voir Ordre du jour spécial)

(See Special Agenda)

- 14 h. *Séances des Commissions. — Sectional meetings.*
Commission I.

Salle A. — Room A.

Structure du Sol — Soil Structure

5. D. PAYNE, Leeds, England. — The determination of the approximate surface areas of soil crumbs.
6. D. PAYNE, Leeds, England. — Some factors affecting the breakdown of soil crumbs on rapid wetting.
7. H. C. PEREIRA, Kikuyu, Kenya. — Soil Structure Criteria for Tropical crops.
8. W. W. EMERSON, Rothamsted, Herts, England. — The effect of various grasses and lucerne on the cohesion of soil crumbs.
13. M. DE BOODT, L. DE LEENHEER, Gand, Belgique. — The practical meaning of pore sizes with respect to the texture of soil.
14. L. DE LEENHEER, M. DE BOODT, Gand, Belgique. — Discussion on the aggregate analysis of soil by wet sieving.

Commission II.

Salle B. — Room B.

Constituants Minéraux — Mineral Constituents

11. M. VAN RUYMBEKE, L. DE LEENHEER, Gand, Belgique. — Etudes comparatives d'analyses granulométriques par décantations successives et par l'hydromètre à chaîne.
21. G. WAEGEMANS, Tervuren, Belgique. — La couleur des latosols en relation avec la nature des oxydes de fer.
22. L. DE LEENHEER, VAN RUYMBEKE, Gand, Belgique. — L'analyse granulométrique par l'hydromètre à chaîne de terres riches en matières organiques.
30. LAMBERTS D. et P. J. LIVENS, Institut Pédologique, Louvain. — L'accumulation d'oxydes de fer dans les sols sur limon loessique.

Commission III.

Salle C. — Room C.

Biochimie du Sol — Soil Biochemistry

1. A. R. PREVOT, M. RAYMOND, P. BIZZINI, B. FISHER, Paris, France. — Recherches sur la ligninolyse bactérienne dans le sol.
6. J. POCHON, J. AUGIER, Institut Pasteur, Paris. — Premières recherches sur l'attaque des hémicelluloses dans le sol.
14. J. NEWTON, Canada. — Microbial Maintenance of Nitrogen in Western Canada's Grey Wooded, black earth (Chernozem) and Brown Prairie Soils.
17. M. TSCHAPEK, M. GIAMBIAGI, Argentine. — The formation of Liesegang's rings by the *Azotobacter* due to the O₂ inhibition.
21. W. C. G. FORSYTH, Trinidad, British West Indies. — The synthesis of Polysaccharides by Bacteria isolated from a Tropical Soil.
26. P. SIMONART, F. PETERS, Heverlé, Belgique. — Acides aminés libres dans l'humus.

Commission IV.

Salle D. — Room D.

Divers — Miscellaneous

3. Hugh NICOL, Glasgow, Scotland. — pL, a numerical soil characteristic.
7. F. STEENBJERG, Roy. Vet. and Agr. Coll., Copenhagen. — On the release of plants nutrients from minerals.
11. R. DE CAESTECKER, L. DE LEENHEER, Gand, Belgique. — Densité végétative des céréales sur divers types de sol et son influence sur la productivité.
16. A. VAN DEN HENDE, Gand, Belgique. — Quelques possibilités du P 32 dans l'étude de la fertilité du sol et de la nutrition des plantes.

*Commission V. — Sous-Commission I - Sub
commission I.*

Salle P. — Room P.

Pedogenèse — Minéraux argileux

Pedogenesis — Clay Minerals

42. J. R. RIQUIER, I.R.S.M., Madagascar. — Formation d'une cuirasse ferrugineuse et manganésifère en région latéritique.
43. J. FRIPIAT et al., Inéac, Congo Belge. — Les argiles des sols de l'Uélé.
44. J. FRIPIAT, M. C. GASTUCHE, J. COUVREUR, Inéac, Congo Belge. — Nature de la fraction argileuse des sols de la vallée du Mosso (Ruanda-Urundi).
45. J. FRIPIAT, M. C. GASTUCHE, J. COUVREUR, Inéac, Congo Belge. — Nature de la fraction argileuse des sols de la vallée de la Ruzizi (Congo Belge).
51. J. FRIPIAT, M. C. GASTUCHE, J. COUVREUR, Inéac, Congo Belge. — Les argiles du sol du Haut-Ituri (Congo Belge).
56. J. FRIPIAT, A. FOCAN, J. COUVREUR, Inéac, Congo Belge. — Les argiles des sols de la région de Kaniama (Haut-Itiru, Congo Belge).

*Commission V. — Sous-Commission 3. - Sub
Commission 3.*

Salle E. — Room E.

Classification — Cartographie des Sols

Classification — Cartography

7. J. D'HOORE, Yangambi, Congo Belge. — The description and classification of free sesquioxide accumulation zones.
8. B. S. ELLIS, Rhodesia. — Some observations on the classification of tropical soils.
10. W. E. CALTON, Dar-Es-Salam. — The catena in relation to the classification of East African soils.

11. W. E. CALTON, Dar-Es-Salam. — Some East African soil complexes : 1. Zanzibar Protectorate.
12. W. E. CALTON, Dar-Es-Salam. — Some East African soil complexes : 2. Tanganyika.
17. Dr P. BURINGH, Delft, Netherlands. — Soil and land classification in Dutch New Guinea.

Commission VI.

Salle E. — Room F.

Classification des Terres — Land Classification

6. J. V. BOTELHO DA COSTA, Ario L. AZEVEDO, Portugal. — Land classification for irrigation in Angola.
9. J. G. STEELE, K. C. VERNON, C. W. HEWITT, Jamaica. — A capability grouping of the soils of Jamaica.
10. R. EAR STORIE BERKELEY, California, U.S.A. — Land classification as used in California for the appraisal of land for taxation purposes.
17. E. ZIPKES, Delhi, India. — A suggested classification of Black Cotton Soils of India.
20. R. PICHEL & A. VAN WAMBEKE, Inéac, Congo Belge. — L'incidence des pouridiés de l'Hévéa en relation avec le sol.
P. RIQUIER, Orsom, France. — Etablissement des cartes d'utilisation des sols à Madagascar.

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- 17 h. 30 Garden party offerte par Monsieur le Gouverneur Général (tenue de ville).
Garden party given by the Governor General (morning dress).

Mardi 17 août

Tuesday, August 17th

- 8 h. *Salle des Conférences générales. — General Lectures Hall.*
1. Dr C. Kellogg. — Soil Conservation.
 2. Professeur G. Aubert. — Les sols latéritiques.

10 h. 30 *Séances des Commissions. — Sectional meetings.*

Commission II.

Salle P. — Room P.

Constituants Minéraux — Mineral Constituents

16. F. A. VAN BAREN, H. KIEL, Amsterdam, Netherlands. — The mineralogy of an apparently autochthonous soil profile in French Equatorial Africa.
23. FRIPIAT J., GASTUCHE M. C., VAN COMPER-NOLLE G., Louvain, Belgique. — Les groupes hydroxyles de surface de la kaolinite et sa capacité d'échange cationique.
25. J. FRIPIAT, M. C. GASTUCHE, J. COUVREUR, A. EKKA, Louvain, Belgique. — Nature de la fraction argileuse des sols du Congo Belge et du Ruanda-Urundi.
26. J. FRIPIAT, M. C. GASTUCHE, J. DELVIGNE, Louvain, Belgique. — L'altération des kaolinites par les agents chimiques.

Constituants Organiques — Organic constituents

1. A. OKUDA, S. HORI, Kyoto, Japan. — Chromatographic Investigation of Amino Acids in humic acid and alcohol lignin.

Commission III.

Salle C. — Room C.

Biologie du Sol — Soil biology

9. M. A. CHALVIGNAC, Institut Pasteur, Paris. — Recherches sur les caractères de *CELLVIBRIO*.
11. H. de BARJAC, Institut Pasteur, Paris. — Essai sur la microflore des tourbières.
20. VALERIE SUTER, Trinidad, British West Indies. — Possibility of Antibiotic Control of the Microflora of the Bachac Nest.

23. F. ALTEN, Allemagne. — Biologische Gesichtspunkte für die Anwendung wirtschaftseigener Dünger für die Erhaltung der Bodengesundheit.
24. VILLAS LOPEZ L., Espagne. — Essais d'adaptation du Rhizobium aux sols acides.
25. H. FRANZ, Autriche. — Artenmannigfaltigkeit der Bodenbiozänen und Bodenfruchtbarkeit.

Commission V. — Sous-Commission 1. - Sub Commission 1.

Salle J. — Room J.

Pedogenèse — Minéraux Argileux
Pedogenesis — Clay Minerals

1. R. MAIGNIEN, Orsom, France. — Formation de cuirasse de plateaux, Région de Labé, Guinée Française.
2. R. MAIGNIEN, Orsom, France. — Cuirassement de sols de la plaine Ballay, Guinée Française.
6. J. D'HOORE, Yangambi, Congo Belge. — Clay mineral and Gibbsite crystals as clues to the mode of formation of ancient sesquioxide accumulation zones.
9. L. LAG, H. BERGSETH, Vollebekk, Norway. — Studies on Acidoid-Basoid relationships of freshly formed Material, suspended in norwegian glacial rivers.
22. M. RIM, Jerusalem, Israël. — The weathering of Natural clays underground as inferred from the preservation of unbaked clay implemets found at archaeological sites.
32. J. M. BASTOS, DE MACEDOS, Portugal. — Note on the development of ferralitic soils from acid and basic rocks.
57. J. Ma. ALBAREDA, Ma. CARMEN CALVO, Madrid. — Etude pédologique-minéralogique de quelques sols de la Guinée Continentale Espagnole.

*Commission V. — Sous-commission 3. - Sub
commission 3.*

Salle E. — Room E.

Classification — Cartographie des Sols
Classification — Cartography

5. Fiorenzo MANCINI, Florence, Italie. — Recent soils surveys in south Italy.
31. J. H. DURAND, Birmandreis, Algérie. — La classification des sols utilisée pour les cartes pédologiques d'Algérie.
35. A. MEEWIS, C.C.C.I., Congo Belge. — Essais de classification par analyse mécanique de quelques sols de la cuvette centrale.
41. G. W. LEEPER, Australie. — The classification of soils; an Australian approach.
47. N. JEWITT, C. MITCHELL, Wad Medani, Soudan. — Methods of Soil Survey in the Anglo-Egyptian Sudan.
54. F. SACE MARQUES, J. CARV. CARDOSO, Portugal. — Les sols de l'Algrave (Sud du Portugal).

Commission VI.

Salle F. — Room F.

Discussion de la Conférence Générale
du Dr C. E. Kellogg

Discussion of the General Lecture
of Dr C. E. Kellogg

- 14 h. 30 *Séances des Commissions. — Sectional Meetings.*
Commission I.

Salle A. — Room A.

L'Eau du Sol — Soil Water

9. M. RIM, Jérusalem, Israël. — Inverse moisture distribution in soil profiles : A manifestation of the dependence of soil moisture characteristics on stress.

10. Erwin FREI, Zurich, Switzerland. — Transpiration and growth of sunflower plants as a function of the soil moisture tension.
11. E. A. BERNARD, Yangambi, Congo Belge. — Fluctuations comparées du déficit d'énergie libre des sols bons et mauvais rétenteurs d'eau, dans le déroulement naturel des fluctuations écoclimatiques.
16. Marc HALLAIRE, I.N.R.A., France. — Diffusion capillaire de l'eau dans les sols et profils hydriques.
17. J. RIQUIER, Orsom, Tananarive, Madagascar. — Commentaires sur l'humidité du sol du 15 février 1952 au 15 février 1953 à Tananarive.
18. SHUNSUKE Takagi, Tokyo, Japan. — Thermodynamics of the capillary rise of soil moisture and Neuman's potential of Capillarity.

Commission III.

Salle C. — Room C.

Techniques de Microbiologie du Sol **Soil microbiology technics**

5. O. MARTRE-COPPIER, Institut Pasteur, Paris. — Essais sur l'évaluation de l'activité des Azotobacter dans les sols.
7. J. AUGIER, Institut Pasteur, Paris. — Techniques permettant d'obtenir des silicogels stériles.
8. J. LAJUDIE, Institut Pasteur, Paris. — Influence des milieux et des conditions de cultures sur l'équilibre de la microflore de la plante in vitro.
10. D. LAVERGNE, Institut Pasteur, Paris. — Représentation graphique de l'activité microbiologique des sols.
16. M. TSHAPEK, A. GARBOSKY, M. GIAMBIAGI, Argentine. — Determination of the sum of substances available in the Soil for Azotobacter.

Commission IV.

Salle D. — Room D.

Divers — Miscellaneous

17. G. D. SCARSETH, Lafayette, Indiana, U.S.A. — Diagnostic techniques to determine fertility status.
21. A. COTTENIE, A. VAN DEN HENDE, Gand, Belgique. — La variabilité de la teneur en éléments minéraux dans les tissus végétaux sous l'influence de la fumure.

M. HOMES, Bruxelles, Belgique. — La méthode des variantes systématiques appliquée au champ.

Commission V. — Sous-Commission 1. — Sub-Commission 1.

Salle J. — Room J.

Pédogenèse — Minéraux Argileux

Pedogenesis — Clay minerals

34. K. R. MIDDLETON, R. D., Sudan. — A soil toposequence in Bahr al Ghazal, Province Sudan (lat. 6° 30' - long. 30° 30' E).
46. G. SCHEYS, R. DUDAL, L. BAEYENS, Louvain, Belgique. — Une interprétation de la morphologie de podzols humo-ferriques.
53. A. VAN WAMBEKE, Inéac, Congo Belge. — L'influence du microrelief « Gilgai » sur la constitution des argiles tropicales de la Lufira.
60. R. DUDAL, J. LIVENS, Louvain. — De l'influence de la mise en culture sur le degré de saturation et la morphologie des sols sur limon loessique.
62. R. TAVERNIER, J. AMERYCKX, C.C.S, Gand. — Quelques considérations sur les facteurs de décalcification dans les Polders Maritimes Belges.

Commission V. — Sous-Commission 2. — Sub-Commission 2.

Salle P. — Room P.

Description — Caractérisation des Sols

Description — Characterisation of Soils

48. J. D. NEWTON, W. ODYNSHY, T. W. PETERS, Alberta, Canada. — Some characteristic bleached Horizon soils of Alberta.
- G. AUBERT, Orsom, France. — Les sols ferrugineux tropicaux d'A.O.F.
- W. KUCZAROW, Inéac, Congo Belge. — Sols des marais de haute altitude au Ruanda-Urundi.
- W. KUCZAROW, Inéac, Congo Belge. — Sols de la région de Kitega (R. U.)
- W. KUCZAROW, Inéac, Congo Belge. — Sols des hauts plateaux de Mugamba.

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- 17 h.15 Visite du Musée de Préhistoire.
Visit to the Museum of Prehistory.
- 17 h. 15 Visite de l'Institut Géographique du Congo Belge.
Visit to the Geographical Institute of Belgian Congo.
- 17 h. 15 Visite de l'Ecole d'Art Saint-Luc.
Visit to the Saint-Luc School of Art.
- 17 h. 15 Visite de l'Usine UTEXLEO.
Visit to the UTEXLEO mills.
- 20 h. Visite du Musée de la Vie Indigène.
Visit to the Museum of Nativ Life.
Séance de cinéma (films réalisés au Congo) au Service de l'Information - Programme A.
Cinema show (films taken in the Congo) in the building of the « Service de l'Information » - Programme A.

Mercredi 18 août
Wednesday, August 18th

- 8 h. *Salle des Conférences Générales. — General lectures hall.*
- 8 h. *Salle des Conférences Générales.*
 General lectures hall.
1. Prof. Dr EDELMAN. — L'importance de la pédologie pour la production agricole dans le monde.
 2. Prof. Dr R. BRADFFIELD. — Soil Structure.
- 10 h. 30 *Séances des Commissions. — Sectional Meetings.*
 Commission I.
 Salle A. — Room A.

Divers — Miscellaneous

- P. VAGELER, Sao Paulo, Brésil. — The triple potential of the soil water and the experimental determination of the « FLEXPOINT ».
- E. A. BERNARD, Yangambi, Congo Belge. — Sur la caractérisation physique des sols souhaitée par l'écoclimatologue pour l'étude rationnelle des interactions atmosphère-sol-végétation.
- E. W. RUSSELL. — The effect of heavy dressings of calcium carbonate on the consistency of clay soils.
- H. C. PEREIRA, Kikuyu, Kenya. — Soil structure aspect of Ley rotation in East Africa.

Commission II.

Salle B. — Room B.

Constituants organiques — Organic constituents

5. C. BLOOMFIELD, Rothamsted, England. — The defloculation of Kaolin by tree leaf leachates.
7. L. MAES, L. DE LEENHEER, Gand, Belgique. — Solubilité de la matière organique dans le fluorure de sodium et degré d'insaturation comme moyen de caractérisation de l'humus dans les sols sablonneux brun et gris sous climat tempéré humide (Belgique).

13. L. A. VALENTE Almeida, R. PINTO RICARDO. — La matière organique des terres noires d'Angola.
14. J. TINSLEY, MAUNG KYAW ZIN, Burma. — The isolation of lignoprotein from sol.

Commission III.

Salle C. — Room C.

**Microbiologie des Sols Tropicaux
Tropical Soils Microbiology**

2. Yvon DOMMERGUES, Tananarive, Madagascar. — Biologie des sols forestiers du centre et de l'Est de Madagascar.
3. Yvon DOMMERGUES, Tananarive, Madagascar. — Etat des recherches de microbiologie du sol à Madagascar.
4. Yvon DOMMERGUES, Tananarive, Madagascar. — Etude de la biologie des sols tropicaux.
12. C. MOUREAUX, I.R.S.M., Madagascar. — Quelques aspects microbiologiques de divers sols du cristallin de Madagascar.
13. J. MEYER, Yangambi, Congo Belge. — Les associations microbiennes du sol.

Commission V. — Sous-Commission 1. — Sub-Commission 1.

Salle P. — Room P.

**Pédogenèse — Minéraux Argileux
Pedogenesis — Clay Minerals**

- R. TAVERNIER, F. R. MOORMAN, Gand, Belgique. — Quelques remarques concernant l'influence de la culture sur le développement du profil pédologique.
- W. KUCZAROW, Inéac, Congo Belge. — Une méthode de préparation de réduction de profils.

Sous-Commission 2. — Sub-Commission 2.

Description — Caractérisation du Sols

Description — Soil Characterisation

R. MARECHAL, J. LARUELLE, Gand, Belgique. — Les sols du Graben centrafricain et les sols de Montagne du Ruwenzori.

G. AUBERT, Orsom, France. — Les sols hydromorphes d'A.O.F.

J. de HEINZELIN, Bruxelles, Belgique. — Paléosols et stratigraphie en Afrique Centrale.

14 h. 30 *Séances des Commissions. — Sectional meetings.*

Commission II.

Salle B. — Room B.

Constituants Organiques — Organic Constituents

27. A. S. de ENDREDY, Gold Coast. — The organic matter content of Gold Coast Soils.

28. LIVENS P. J. & DEGRY H., Louvain. — L'extraction de matières humiques par le fluorure d'ammonium.

29. Fr. APPELMANS, L. de LEENHEER, Gand, Belgique. — Existe-t-il une corrélation entre les teneurs en matières organiques et en carbonate de calcium dans les sols des Polders marins belges ?

ERDTMANN H.G.H., Stockholm, Suède. — Model experiments of the formation and structure of humic acids.

Commission III.

Salle C. — Room C.

Microbiologie des Sols Tropicaux

Microbiology of Tropical Soils

15. D. A. van SCHREVEN. — The influence of a wet rice culture on the survival of Tobacco Virus I, Phytophthora Parasitica Var. Nicotianae and Pseudomonas Solanacearum on tropical Soils.

18. J. E. ROMBOUTS, N. V. PHILIPS, Graveland, Netherlands. — Some soil relations of the endotrophic mycorrhiza of cacao in Trinidad. B. W. I.
19. H. B. MORRIS, Trinidad, British West India. — Some notes on the affinity between strains of *Chromobacter Violaceum* and *Chromobacter lanthinum* isolated from Trinidad Soils.
15. J. MEIKLEJOHN, Rothamsted, England. — Nitrogen-Fixing Bacteria from East African Soils.

Commission IV.

Salle P. — Room P.

Divers — Miscellaneous

2. J. KORTLEVEN, Groningen, Netherlands. — Soil organic matter and plant growth.
13. D. STENUIT, Louvain, Belgique. — La détermination de la carence en magnésie dans les sols belges.
14. D. STENUIT, Louvain, Belgique. — Champs d'essais comparatifs sur magnésium avec différents engrais potassiques.
12. D. STENUIT, Louvain, Belgique. — L'influence de la réaction (pH) sur le rendement des cultures dans les différentes régions agricoles belges.

Commission V. — Sous-Commission 2. — Sub-Commission 2.

Salle J. — Room J.

Description — Caractérisation des Sols

Description — Characterisation of Soils

2. R. MAIGNIEN, Orsom, France. — Les sols subarides en A.O.F.
13. H. BRAMMER, A. S. de ENDREDY, Gold Coast. — The tropical black earths of the Gold Coast and their associated vlei soils.

15. Dr R. HAMILTON, Gold Coast. — A note on the black soils of the Gold Coast.
21. C. R. VAN DER MERWE, Pretoria, Union of South Africa. — Kalahari and Sahara sandy soils.
33. K. R. MIDDLETON, R. D. Sudan. — A suggested name for certain Sudan clay soils.

Commission VI.

Salle F. — Room F.

Conservation du Sol — Soil Conservation

7. J. R. BASU, Poona, India. — A survey of the recent development in soil conservation in India.
8. Ario L. AZEVEDO, Portugal. — The technology of peaty soils in Moçambique and Angola.
13. T. N. JEWITT, Sudan. — Soil conservation in the Sudan.

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- 17 h. 15 Visite du Musée de Préhistoire.
Visit to the Museum of Prehistory.
- 17 h. 15 Visite du Musée de Géologie (commentaires en français).
Visit to the Geological Museum (comments in french).

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- 17 h. 15 Visite du Laboratoire des Travaux Publics.
Visit to the Laboratory of the Public Works Department.
- 17 h. 15 Visite du Jardin Zoologique.
Visit to the Zoological Garden.

Jeudi 19 août

Tuesday, August 18th

- 8 h. *Salle des Conférences Générales. — General lectures Hall.*
1. Dr H. GREENE. — Some aspects on the fertilisation of Soils in Africa.

2. Prof. Dr BOTELHO da COSTA. — Quelques aspects des rapports sol-eau-plante.

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10 h.30 *Séances des Commissions. — Sectional meetings.*

Commission I.

Salle P. — Room P.

Eau du Sol — Soil Water

15. S. TOVBORG JENSEN, Denmark. — Determination of water Content and specific gravity in soil samples by means of Pyknometers.

Divers — Miscellaneous

1. S. HENIN, LE BORGNE, Versailles, France. — Sur les propriétés magnétiques des sols et leurs interprétations pédologiques.
2. S. CAILLERES, P. BIROT, S. HENIN, Versailles, France. — Etude expérimentale du mécanisme de la désagrégation de quelques roches éruptives et métamorphiques.
4. E. R. FOUNTAINE, P. C. PAYNE, Nat. Inst. of Agr. Engin., England. — Causes of non-scouring in soil working implements.

Commission II.

Salle B. — Room B.

Propriétés chimiques et physiques du sol Chemical and physical proprieties of soils

6. L. DE LEENHEER, L. MAES, Gand, Belgique. — Influence de la nature du sol sur l'étude comparative de la détermination de la capacité de sorption par différents liquides de percolation.

12. L. DE LEENHEER, F. APPELMANS, Gand, Belgique. — Influence of the treatment of soil samples with H_2O_2 on the exchange capacity of the mineral soil fraction.
17. MAN. H. YAALON, Hebrew University, Jérusalem, Israël. — Physico-chemical relationships of $CaCO_3$, pH and CO_2 in calcareous soils.
20. LIVENS, P. ., Heverlee, Belgique. — Le degré de saturation d'une séquence de sols forestiers sur limon loessique.

Commission V. — Sous-Commission 2. — Sub-Commission 2.

Salle J. — Room J.

Description — Caractérisation des Sols

Description — Characterisation of Soils

24. N. LENEUF, Orsom, France. — Des terres noires du Togo.
28. Ario L. AZEVEDO, J. V. BOTELHO DA COSTA, Portugal. — Les terres noires d'Angola.
64. J. THIRION et J. NISOT, C.N.Ki. — Contribution à la connaissance des sols à horizon foncé en profondeur, des régions d'altitude de l'Est du Congo Belge. INEAC, Yangambi, Congo Belge. — Latosols à horizon sombres des Hauts Plateaux africains.
R. V. RUHE, J. C. CADY, U.S.A. — Latosolic soils of Central African Interior High plateaux.

Commission VI.

Salle F. — Room F.

Conservation du Sol — Soil Conservation

2. D. A. CAMPBELL, New Zealand. — Giving Wings to soil conservation in New Zealand.
3. F. R. DREIBELBIS, L. L. HARROLD, U.S.A. — The rôle of soil in the hydrologic cycle.

11. T. N. JEWITT, J. S. MAUTON. — Soil exhaustion in the Goz sands of the Sudan.
14. T. W. EDMINSTER, Beltsville, U.S.A. — Engineering applications of soil permeability data.
18. H. C. PEREIRA, Kikuyu, Kenya. — Soil water storage under Catchment area vegetation.

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- 14 h. Excursion géologique.
 Geological excursion.
- 18 h. Visite de la Brasserie de Léopoldville.
 Visit to the Leopoldville Brewery.

Vendredi 20 août
Friday, August 20th

- 8 h. 30 Séances des Commissions. — Sectional meetings.
 Commission II.

Salle B. — Room B.

Propriétés chimiques et physiques du sol Chemical and physical soil properties

4. J. CH. VAN WESEMAEL, J. J. LEHR, Wageningen, Holland. — The influence of salt on the solubility of phosphate in iron rich soils.
8. H. M. VAN DER MAREL, Groningen, Netherlands. — The amount of exchangeable cations of K fixating soils.
24. P. J. LIVENS, R. VANSTALLEN, Louvain, Belgique. — Le pH comme indice du degré de saturation.
27. A. S. de ENDREDY, Gold Coast. — The Organic matter content of Gold Coast Soils.
31. L. MARTIN et A. ROTTI, I.R.S.I.A., Belgique. — Aperçu sur l'utilisation des méthodes biométriques dans l'analyse chimique du sol.
32. A. VAN DEN HENDE, A. COTTENIE, L. MARTENS, Gand, Belgique. — Recherches sur la sensibilité et la signification de différentes méthodes d'analyses chimiques.

Commission IV.

Salle D. — Room D.

Fertilité des Sols Tropicaux

Fertility of Tropical Soils

1. R. FAUCK, Orsom-Sefa, Sénégal. — Premières observations sur les relations engrais verts, engrais chimiques en moyenne Casamance.
4. D. H. SAUNDERS, South Rhodesia. — Assesment of soil fertility for advisory purposes.
5. E. W. BOLLE JONES, Rub. Res. Inst., Malaya. — The interrelationships of magnesium potassium and phosphorus and their effect on the growth and composition of hevea brasiliensis.
8. J. VAN GARDEREN, Union of South Africa. — The superphosphate — yield curve in fertilizer experiments.
10. R. R. MIDDLETON, Soudan. — Distribution of total phosphate and its relation to available phosphate in certain Sudan soils.
18. L. A. VALENTE ALMEIDA, V. H. BROCHADO de MIRANDA. — Les formes de phosphore dans les sols d'Angola.
20. E. BELLIS, Nairobi, Kenya. — A review of fertilizer responses in Kenya.

Commission V. — Sous-Commission 2. — Sub-Commission 2.

Salle J. — Room J.

Description — Caractérisation des Sols

Description — Characterisation of Soils

4. J. P. BOX, New Zealand. — Note on the occurence of a Red-Yellow Podsollic soil and associated soils from water podsol on VITI-LEVU - FIJI.
14. W. KUBIENA, Institute of Soils and Plant Physiology C.S.I.C., Madrid, Spain. — Micromorphology of laterite formation in Rio Muni (Spanish Guinea).

25. YUTAKA KAMOSHITA, Tokyo, Japan. — Soil types in Japanese paddy rice field.
26. A LAPLANTE, Orsom, Cameroun. — Les sols rouges latéritiques formés sur les basaltes anciens au Cameroun.
30. Alcides FRANCO, Rio de Janeiro, Brasil. — Soils in the region of Serido R.G.N.
P. SEGALIN, I.R.S.M., Madagascar. — Sur l'existence d'un sol latéritique brun à Madagascar.
J. M. BRUGIERE, Institut d'Etudes Centrafricaines. — Les argiles faiblement latéritiques à concrétions ferrugineuses de la vallée du Niari.

Salle P. — Room P.

Sous-Commission 3. — Sub-Commission 3.

Classification — Cartographie des Sols

Classification — Cartography of Soils

18. G. A. WORRALL, Khartoum, Sudan. — Soil Mapping and its relation to Geological Mapping in S. E. England.
19. G. A. STEWART, Camberra, Australia. — The soils of Monsoonal Australia.
29. C. G. STEPHENS, C.S.I.R.O., Australia. — The classification of Australian Soils.
39. E. MUECKENHAUSEN, Krefeld, Germany. — A plan of a classification system of the soils in Germany.
59. A. NOIRFALISE, I. DENISOFF. — Géomorphologie, sol et végétation du Parc National de la Garamba.

Commission VI.

Salle F. — Room F.

Erosion du Sol — Utilisation
Soil Erosion and Management

1. A. W. ZINGG, U.S.A. — Mechanics of soil erosion by wind.
4. R. FAUCK, Orsom, Sénégal. — Les facteurs et les intensités de l'érosion en moyenne CASAMANCE.

5. W. D. ELLISON, U.S.A. — Mechanics of water-erosion.
12. T. N. JEWITT, K. R. MIDDLETON, Sudan. — Irrigation problems in the Sudan.
15. O. J. KELLEY, Beltsville, U.S.A. — Soils problems related to irrigation.
16. G. STEFANELLI, Bologne, Italie. — La résistance spécifique du terrain à l'effort tranchant et sa mesure en plein champ par un nouvel appareil.

14 h. 30 *Commission II.*

Salle B. — Room B.

Le Sol et la Plante — Soil and Plant

2. P. VAGELER, Sao Paulo, Brésil. — Calculation of Natural harvests and fertilizer necessity by soil analysis.
3. H. LAUDELOUT, J. MEYER, Inéac, Yangambi. — Les cycles d'éléments minéraux et de la matière organique en forêt équatoriale congolaise.
9. E. W. RUSSELL, Oxford, England. — The availability of salt or fixed phosphate to plants.

Commission IV.

Salle P. — Room P.

**Fertilité des Sols Tropicaux
Fertility of Tropical Soils**

6. P. ROCHE, J. VELLY, B. JOLIET, Tananarive, Madagascar. — Fertilisation des sols de rizières dans la région du Lac Alaotra, Madagascar.
9. R. A. WEBB, Gambia. — The investigation of mineral deficiencies of some african soils.
15. M. GREENWOOD, Bristol. — Sulphur deficiency in Ground - nuts in Northern Nigeria.
19. A. S. de ENDREDY, C. W. MONTGOMERY, Gold Coast. — Some Nutrient Aspects of the Gold Coast Forest Soils.

Commission V. — Sous-Commission 2. — Sub-Commission 2.

Salle J. — Room J.

Description — Caractérisation des Sols

Description — Characterisation of Soils

27. A. LAPLANTE, Orsom, Cameroun. — Les sols foncés tropicaux d'origine basaltique au Cameroun.
36. E. M. CHENERY, Dept Agriculture, Uganda. — Acid sulphate soils in central Africa.
37. C. MOUREAUX, I.R.S.M., Madagascar. — Description d'un sol salé rouge dans le Sud-Ouest de Madagascar.
40. C. R. VAN DER MERWE, Pretoria, Union of South Africa. — Subtropical brown forest-soils.

Commission VI.

Salle F. — Room F.

Erosion du Sol — Utilisation

Soil erosion and management

19. Dr M. Y. SHAWARBI, University of Cairo. — The Comparative Effects of certain Soil Treatments on Cotton yield in Egypt.
21. R. VAN GANSE, Laboratoire des Travaux Publics, Congo Belge. — Les sols congolais dans la construction routière.
22. E. de la PERSONNE, Cameroun. — Essais de motoculture et fumure de la ramie au Cameroun.

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- 17 h. 15 Visite du Musée de Géologie (commentaires en anglais).
Visit to the Geological Museum (comments in english).
- 17 h. 15 Visite de l'Ecole des Chauffeurs de la Force Publique.
Visit to the training school for Service drivers.

- 17 h. 15 Séance de cinéma (films réalisés au Congo)
au Service de l'Information - Programme B.
Cinema show (films taken in the Congo) the
« Service de l'Information ».
- 20 h. Visite du Musée de la Vie Indigène.
Visit to the Museum of Native Life.
- 20 h. Cercle Hippique : Attribution de la Coupe du
Congrès de la Science du Sol.
Riding dispean at the « Cercle Hippique ».
The President of the Congress will give the
« Congress » Cup to the winner.

Samedi 21 août

Saturday, August 21th

- 8 h. 30 *Séances des commissions. — Sectional sections.*
Commission II.
Salle B. — Room B.

Le Sol et la Plante — Plant and Soil

10. H. LAUDELOUT, R. GERMAIN, Yangambi, Congo
Belge. — Premiers résultats sur la dynamique chimique
des jachères herbacées et des pâtures à Yangambi.
15. A. C. SCHUFFELEN, H. A. MIDDELBURG, Wa-
geningen, Holland. — A rapid method for the deter-
mination of the base exchange capacity of plant roots.
18. SHINGO MITSUI, SUE ASO, KIKUO, KUMA-
ZAWA TATSUO ISHIWARA, Tokyo, Japan. —
The nutrients uptake of rice plants as influenced by
Hydrogen sulfide and butyric Acid abundantly evol-
ving under water logged soil conditions.
19. J. A. BONNET, AR. Riera, Puerto Rico. — Radio-
active studies with P32 in tropical soils and crops
of Puerto-Rico.

Commission IV.

Salle D. — Room D.

Fertilité des Sols Tropicaux
Fertility of Tropical Soils

M. HOMES & M^{11e} VAN SCHOOR, Bruxelles, Belgique. — Composition chimique du palmier à huile en fonction de la fumure.

J. D. FERWERDA, Yaligimba, Congo Belge. — Fertilizing of the African Oil Palm cultivation.

H. BROESHART, Yaligimba, Congo Belge. — The use of foliar analysis in oil palm cultivation.

ELLIS B. S., Salisbury S. Rh. — Assessment of Soil Fertility for advisory purposes in Southern Rhodesia.

A. S. ENDREDY, C. W. MONTGOMERY, Gold Coast. — Some nutritional aspects of Gold Coast Cocoa soils.

Commission V. — Sous-Commission 2. — Sub-Commission 2.

Salle J. — Room J.

Description — Caractérisation des Sols
Description — Characterisation of Soils

23. Manuel DEL LIANO, Colombia. — Notas a la nomenclatura sobre suelos equatoriales.
61. DE LEENHEER, L., APPELMANS, F. & DE CAESTECKER, K. — Sur la valeur objective des évaluations de la texture sur le terrain et sur le rôle de certaines fractions granulométriques dans ces évaluations.
63. PAHAUT P., C.C.S., Louvain. — Les sols sur craie tendre et calcaire dur du pays de Herve.

73. C. F. CHARTER, S. A. RAQWANSKY, Gold Coast. — Soils developed over ancient drifts in the Gold Coast.
74. C. F. CHARTER, J. Mc G. HOTSON, Gold Coast. — Some soils of the Gold Coast Forest Region.
75. G. MANIL, A. PECROT, Gembloux, Belgique. — Les sols bruns forestiers oligotrophes de la Belgique.

Commission V. — Sous-Commission 3. — Sub-Commission 3.

Salle P. — Room P.

Classification — Cartographie des Sols
Soil Classification — Cartography

16. Dr P. BURINGH, Delft, Netherlands. — The analysis of pedological elements in aerial photographs.
20. G. A. STEWART, Canberra, Australia. — Some aspects of Soil Taxonomy.
55. P. BURINGH, VAN LERE, Delft, Hollande. — Example of a Reconnaissance soil map produced by the pedological analysis of aerial photographs.

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- 17 h. *Salle des Conférences Générales. — General Lectures Hall.*
Réunion de la Société Internationale de la Science du Sol.
Meeting of the International Soil Science Society.
(Voir ordre du jour spécial)
(See special Agenda)

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21 h. Séance de danses congolaises organisée au Parc De Bock en l'honneur des congressistes.
Display in the De Bock Park in honour of the members of the Congress.

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Dimanche 22 août
Sunday, August 22th

Excursion sur le Pool et à Brazzaville, offerte aux congressistes (départ à 10 heures, retour vers 18 heures).

Excursion on the Pool and visit to Brazzaville organized for the members of the Congress. (departure, 10 a.m., return about 6 p.m.)

Lundi 23 août — Mercredi 25 août
Monday, August 23th — Wednesday, August 25th

Excursion dans le Bas-Congo (I).

Excursion to the Lower Congo (I).

Jeudi 26 août
Thursday, August 26th

Départ de l'excursion à Yangambi (II)

Departure for Excursion to Yangambi (II).

Imprimerie ELITE
Léopoldville

V^e CONGRÈS INTERNATIONAL
DE LA SCIENCE DU SOL

Vth INTERNATIONAL CONGRESS
OF SOIL SCIENCE

(Léopoldville, 9-14 / VIII / 1954)



LISTE DES MEMBRES
LIST OF MEMBERS

(Arrêté à la date du 1^{er} août 1954)

(Closed August 1st 1954)

La présente liste sera éventuellement amendée ou complétée durant le Congrès.

If necessary, this list will be amended or completed during the Congress.

V^e CONGRÈS INTERNATIONAL
DE LA SCIENCE DU SOL

Vth INTERNATIONAL CONGRESS
OF SOIL SCIENCE

(Léopoldville, 9-14 / VIII / 1954)



LISTE DES MEMBRES
LIST OF MEMBERS

(Arrêté à la date du 1^{er} août 1954)

(Closed August 1st 1954)

Afrique du Sud (Union de l') (South Africa)

- 4 ALTONA, Roland, Edwin, Dr, Agronomist, Johannesburg.
- 76 GRANT, Penelope, Mary, Dr, Agricultural Research Chemist, *Research Department Northrand*, Johannesburg.
- 167 VAN DER MERWE, Christiaan, Rudolph, Dr, Technical Adviser, *Division Chemical Services*, Pretoria.
- 168 VAN GARDEREN, Jacob, Dr, Officer in charge, *Gvt. Chem. Lab.*, Pretoria.
- ~~174 VENN, Anthony, Claude, Soil fertility Officer, Department of Agriculture, Basutoland.~~
- 176 VILJOEN, Nico, Dr, Agricultural Adviser, Durban.

Afrique Equatoriale Française (French Equatorial Africa)

- 17 BOYER, Jean, Louis, Marie, Chef de Travaux de Laboratoire, Pédologue en Oubangui-Chari, *Station de Gounouman*, Alindao.
- *182 BOYER, (M^{me} J.)
- 22 BRUGIERE, Jean-Marie, Maître de Recherches, Chef du Service Pédologique de l'*Institut d'Etudes Centrafricaines*, Brazzaville.
- 27 BUSCH, Jean, Louis, Georges, Chef de Travaux de Laboratoire, Chimiste, *Station de Boukoko M'Baiki*, Oubangui.

Afrique Occidentale Française (French West Africa)

- 12 BELLOUARD, Pierre, Conservateur des Eaux et Forêts, Inspecteur des *Sections de Recherches forestières de l'A.O.F.*, Dakar, Sénégal.
- 16 BOUYER, Serge, Ing. agr., Licencié ès Sciences, Chef de la Subdivision d'Agrologie, *Centre de Recherches agronomiques de Bambey*, Sénégal.
- 71 GAUDY, Maurice, Ingénieur en Chef des Services de l'Agriculture, Secrétaire permanent du *Bureau des Sols en A.O.F.*, Président du Comité de l'Ouest africain des Sols, Dakar, Sénégal.
- 99 LAMOUROUX, Maurice, Ing. agr., Chargé de recherches, Lomé, Togo.
- 108 LENEUF, Noël, Chargé de recherches à l'O.R.S.T.O.M., *Service pédologique*, Abidjan, Côte d'Ivoire.
- 113 MAIGNIEN, Roger, Maître de recherches à l'O.R.S.T.O.M., Chef du *Centre de Pédologie de Hann*, Dakar, Sénégal.
- 122 MOULINIER, Hubert, Maître de recherches, Directeur du Laboratoire de pédologie du *Centre de Recherches agronomiques de Bingerville*, Côte d'Ivoire.
- 130 OCHS, Robert, Camille, Ing. agr., Chimiste du Sol à l'*Institut de Recherches des Huiles et Oléagineux*, c/o O.R.S.T.O.M., Adiopodoumé, Côte d'Ivoire.
- 175 VEROT, Pierre, Chef de Travaux, Directeur de la Section de pédologie du *Centre de Recherches Agronomiques de Kankan*, Guinée.

Afrique Orientale Britannique (British East Africa)

- 6 ANDERSON, Brian, Soil Chemist, Tanganyika Ty.
- 11 BELLIS, Edwin, Soil Chemist, *Agric. Dept.*, Nairobi, Kenya.
- 28 CALTON, William, Ernest, Government Chemist, *Chemical Laboratory*, Dar-es-Salaam, Tanganyika Ty.
- 32 CHENERY, Ernest, Martin, Dr, Senior Chemist, *Dept. of Agriculture*, Kampala, Uganda.
- 107 LE MARE, Peter, H., Soil Chemist, *Cotton Research Station*, Kampala, Uganda.
- 109 LEUTENEGGER, Fridolin, Dr Sc., Soil Chemist, *Sisal Research Station*, Ngomeni, Tanganyika Ty.
- 139 PEREIRA, Herbert, Charles, Dr, Soil Physicist, E.A.A.F.R.O., Kenya.
- 153 SPURR, Arthur, Michael, Marshall, M.R., Geologist, *Geological Survey Dpt.*, Dodoma, Tanganyika Ty.
- 185 TRAPNELL, C.G., E.A.A.F.R.O., Kenya.

Algérie (Algeria)

- 29 CAPOT-REY, Robert, Emile, Professeur à l'Université d'Alger, Directeur de l'*Institut de Géographie d'Alger*.
- 58 DURAND, Jacques, Henry, Ing. Dr, Chef de la Station pédologique du Service des études scientifiques, *Service de la Colonisation et de l'Hydraulique*, Alger.

Allemagne (Germany)

- 3 ALTEN, Friedrich, Prof., Dr, Leiter der Wiss. Abt. der *Verkaufsgemeinschaft Deutscher Kaliwerke*, Hannover.
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Belgique (Belgium)

(Voir aussi : Congo Belge)

(See also :

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Cameroun (French Cameroun)

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France

(Voir aussi :

(See also :

- Afrique Equatoriale Française, Afrique Occidentale)
Française, Algérie, Cameroun, Madagascar, Maroc.)
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- 133 OUDIN, Auguste, Directeur de l'*Ecole Nationale
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- 141 PREVOT, André, Romain, Prof., Chef de Service
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- 164 TROCHAIN, Jean, Louis, Dr Sc., Professeur à la
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Gambie
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Grande-Bretagne (Great Britain)

(Voir aussi :

(See also :

Afrique Orientale Britannique, Basutoland, Côte de l'Or, Gambie, Jamaïque, Maurice, Nigéria, Sierra-Leone.)

- 52 BARKER, Frank, *Service de Traduction de la C.C. T.A.*, Interprète du Congrès, London.
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(Voir aussi : Nouvelle Guinée Néerlandaise.)

(See also :

- 24 BURINGH, Pieter, Dr, Lecturer in Soil Science, *International Training Center for Aerial Survey*, Delft.
- 60 EDELMAN, Cornelis, H., Dr, Professeur à l'*Institut Agronomique de Wageningen*.
- 96 KORTLEVEN, Jacob, Ing. agr., Paterswolde.
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Portugal

(Voir aussi : Angola, Mozambique.)

(See also :

- 15 BOTELHO DA COSTA, Joaquim, V., Ing. agr., Ph. Dr (Lond.), Professeur de Pédologie et Conservation du Sol à l'*Institut Agronomique de Lisbonne*, Chef de la Mission de Pédologie en Angola.
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OPENING ADDRESS OF THE CONGRESS

SOIL SCIENCE AND EVOLUTION OF AGRICULTURE IN TROPICAL
AFRICA.

By F. JURION.

It has now become a tradition that the Congress of the Society for Soil Science should be opened by an address of the President. In Amsterdam, when you did me the honour and gave me the responsibility of presiding over your debates, I did not realize that in addition to the many responsibilities awaiting me, I should also have to speak to you on a subject relating to soil science. My predecessors were all eminent pedologists, particularly qualified. Hence you will realize the apprehension of an agronomist now become an administrator of agricultural research when called upon to speak before such a competent audience. A long career in agriculture in tropical areas has provided me, however, with many opportunities of tackling problems where the knowledge of soils was essential. Experience has taught me to appreciate the services rendered by agrological research on the evolution of agriculture and to found bright hopes on its influence in the future evolution of agricultural speculations.

This will be the theme of my exposé, which, with your permission, I shall limit to the particular case of the Belgian Congo. For I am convinced that the methods adopted in the Congo to bring agriculture to its present level, which could be the starting point of a further step in the way of progress and of which I shall place before you the essential elements, can quite properly be applied to other equatorial areas in the world.

It is not inappropriate, at the beginning of this exposé, to recall some historical facts. The civilizing mission of the Belgians in the Congo dates back to 1885. At that time, King Leopold II, the founder of the Independent State of Congo, had entrusted to his associates the primordial task of pacifying the country and protecting it against the activities of slave traders. Our famous Sovereign could not, however, achieve these basic humanitarian objects without adequate resources, so that he soon examined the possibilities of making use of natural resources and of increasing the value of human effort by starting plantations and introducing useful plant species. The first introduction garden of Eala dates back to 1901 whereas the railway line between Leopoldville and the sea had only been opened since 1898. At that time the Sovereign King had only at his disposal men of good will whose experience in matters of agriculture was often somewhat sketchy. The best they could do was to apply, without discrimination, the methods they had learnt in their country of origin. Results were disappointing.

In 1908 when Belgium decided to pursue the task undertaken by its King, the Government, convinced of the primordial part played by agriculture in the prosperity of the populations it was undertaking to protect, established a first network of experimental stations distributed throughout the Colony, in wisely chosen places. Some of these establishments are still flourishing to-day. The creation of this network of experimental stations found its inspiration in the example given by the Far East, where English and Dutch had given a remarkable impulse to tropical agriculture. The task of these agricultural stations was to test species, before extending their cultivation, and to experiment with methods applied in other longitudes. The pioneers of those days were concerned with a knowledge of the soil. The first soils analysis laboratory was established as early as 1910. A few maps, classifying soils according to their texture, had even been drawn up before 1916. In spite of these more rational foundations, developed specially after the first world war, success was only partial, and wherever sufficient precautions had not been taken as regards choice of soils, further failures were recorded. Methods

of cultivation such as complete incineration, grubbing of tree stumps, repeated ploughing, clean weeding, all intended to provide the plants with the maximum of useful elements, and all showing satisfactory results in the beginning, brought about in the end an excessive exhaustion of the soil and a regression of outputs. These methods were fully applied, without corrective measures, until about 1938.

In the meantime the network of climatic observations had been developed and a study of soils had been undertaken on more modern bases. The first results of these observations and of the research work revealed one reason why methods recommended in the Far East were not applicable to the Belgian Congo. It was obvious that most of the soils of the Congo were very poor and that the climate, of a Continental nature, was marked by a comparatively low and variable rainfall and by low radiation. These climatic factors, which condition all others, contribute further to weaken the general index of original fertility.

The improvement of cultivated plants, despite certain spectacular results, has only partly concealed the consequences of these inadequate methods of cultivation.

Further progress in the knowledge of the factors of physical and biological environments and further study of the customary methods of cultivation of the natives were to determine a new trend both in the handling of permanent plantations and annual crops. As far as the former are concerned, the method of incineration was abandoned; so was ploughing. Weeding was restricted to the removal of plants known to be harmful and, insofar as the habitus and ecological requirements of the cultivated plant permitted, attention was given to achieving associations of natural and introduced plants ensuring an efficient cover and the rhizosphere of which reached various layers on the soil. This method, which calls for a degree of art on the parts of the agriculturists in order to maintain a proper balance between cultivated plants and natural growth, has given good results. Production was maintained at a satisfactory level, the quality of the humus was stabilized, the structure of the soil, a particularly labile property of Congo soils was better preserved, micro-edaphic associations became more stabilized and reacted satisfactorily on the less generalized incidents of root diseases.

As far as temporary cultivation was concerned, a study of native methods, and particularly of the so-called "bantu" system brought about the postponement of the application of apparently better methods which included ploughing, pure cultivation, short fallows, etc. The so-called "Bantu" system is based on a preparation of the soil reduced to a minimum, a short cycle of cultivation, the association of various plants and periods of natural fallows varying according to areas, though always of long duration.

Large numbers of experiments led to the rationalization of this customary system, to the development of a cycle of cultivation integrating economic speculation, the adoption of better methods facilitating the establishment and protection of fallows. This is what we call "corridor cultivation" in forest areas and "strip cultivation" in savannah areas. In fact, we have merely rationalized and brought under control the method so extensively criticized of shifting cultivation. Applied on a large scale by the Department of Agriculture in the many indigenous farms thus organized, it has made possible the paradox of stabilizing native farmers practising shifting cultivation. In the short time at my disposal I cannot expound or comment on these developments, but the documentation before you, or available to you in the premises of the Congress, and such observations as you will not fail to make in the course of one of our excursions, will enable you to assess them. I shall merely mention a few figures. At the end of 1953, 118,446 families were settled for the purpose of applying this method of farming over an area of about 12,000 km².

These first results were obtained thanks to the cooperation of agronomists and various experts and particularly with the assistance of pedologists. Soil physicists had to delve into the problems of structure and water supplies. Physico-chemists followed the transformation of colloids for the purpose of determining the duration of crop and fallow cycles. Microbiologists tackled the basic problems, particularly in hot climates, of organic matter in relation to cultivation in those part or the regenerating cover and the condition of exhaustion or of restoration of the soil. Mineralogists had considered the problem of pedogenesis, particularly that of lateritic soils.

This joint study of systems of cultivation appropriate to conditions in the Congo, had revealed the need for a better knowledge of types of soil and the value of rational mapping.

Economic and social requirements appeared beside the technical ones. The higher standard of living among the industrial population automatically gave rise to identical and perfectly legitimate demands on the part of plantation workers and farmers. It became necessary to balance the rise in the value of human effort by maintaining prices at a remunerative level. In a farming system which remains extensive, such a compromise is only possible by increasing production. The per unit of surface utilization of soils according to their vocation, an essential condition of consuming their economic value was then fully realized, and the need for adequate mapping became obvious.

In 1934-35, Chanoine Baeyens, one of the pioneers of Belgian pedology, laid the first stone of that sound structure which will some day become the soils map of the Belgian Congo. This first effort was interrupted however, by the second world war, when all research not posted for military duties, had to devote their activities to work of more immediate value. It is only in 1946 that the departments of pedological research were reorganized and that work in the field was once more undertaken, at the same time as laboratories were resuming their interrupted research work. Soil survey and classification were completed by a simultaneous survey of the vegetal cover. Such comparison of the features of the soil and of the vegetation contributes to pedological reconnaissance and to the interpretation of aerial photography. The latter can be of considerable assistance, even for the study of such closed landscapes as areas covered by equatorial forests.

The systematic mapping of the Belgian Congo represents an enormous undertaking, although it is still our ambition to achieve it. The first tasks assigned to surveyors were on a less ambitious scale, and aimed at clearly defined objectives. The principal object of such maps as are now completed is to serve as a basis for the development of new areas or for a more rational organization of areas already occupied. Surveys include sample areas carefully chosen after a wide reconnaissance of the natural area under consideration. Maps of the soil and of the vegetation are completed by a plan for the utilization of soils according to their agricultural, pastoral or forestry vocation. The indications obtained from work in the field by these pedo-botanical surveys are, or will gradually be, extended and completed by laboratory analysis of samples of soils or herbarium determination of indicative plant species. Thus the lessons learnt from a sample area can be extended to a whole ecological area, by implementation services in the case of native agriculture, or by agricultural officers of European organizations. Mapping officers thus become, more and more, the pioneers in all agricultural progress.

So far I have only touched upon one of the aspects of soils conservation: maintaining their fertility. This is the most important problem for the Congo as a whole. In order to be complete, however, I should also mention mechanical erosion which is one of the extreme aspects of degradation. Though it does not appear in the spectacular

or disastrous forms observed in certain countries, erosion nevertheless causes fairly serious damage in hilly country, particularly in the Eastern Congo and the Ruanda-Urundi. In these territories of dense populations, often overstocked, preventative measures for conservation are insufficient and efficient remedies are imperative. Such remedies are tested and widely popularized by government departments responsible for their application of which the Anti-erosion Mission is the advising body. The methods applied tend to create protecting afforestation on the ridges of water sheds and to establish anti-erosion works by mechanical means.

The M.A.E. also undertakes to solve certain problems of irrigation and drainage. Beside these efforts conducted according to progressive methods and with powerful equipment, one should not omit to mention the anti-erosion work already carried out by hand at the instigation of the Department of Agriculture. In the Ruanda-Urundi, for instance, at the end of 1953, 525,870 acres had been protected by delimiting terraces, planting hedges, or digging ditches amounting to a total of 133,125 miles.

I have just painted a rough picture of the various stages of the evolution of agriculture in the Congo to date. In conclusion our systems of cultivation, inspired as they are by customary methods, tend more and more to conserve the fertility of the soil. Thanks to a more careful choice of soil, to a more rational treatment guided by experiments in the field, and to laboratory research work, a first compromise has been reached between production and soils conservation.

This compromise method of cultivation, at least as far as seasonal speculations customary among the African are concerned, is not only adapted to the ecological surroundings but also to the degree of social evolution of the human element. Though it may constitute a progress inasmuch as the value of the land is guaranteed, and its economic value is increased, it remains nevertheless a primitive system of agriculture calling only for the sweat of the peasant and particularly that of his wife, in addition to primitive tools such as an axe, a matchete and a hoe. These hands and tools represent, so far, the only working capital of the agricultural population of Central Africa. There is no cause for surprise in this, for their first contact with Western civilization dates back scarcely half a century.

The evolution of these peasants may be slow and not lend itself to the sudden introduction of more progressive agricultural methods; nevertheless, it does proceed uninterrupted. Widely applied education and technical training supported by the industrial development of a country rich in mineral resources and in hydroelectric power will gradually change the requirements and demands, even of the rural populations. In a future that may still be distant, albeit foreseeable, the man who tills the soil will remain attached to it only insofar as he derives better subsistence from it. Otherwise, rural populations will migrate in excessive numbers towards industrial centres. The increasing demands of industry, as also those of large scale farming undertakings always in need of more labour, will gradually deplete the independent rural population. It is therefore necessary to consider at this stage how to increase the value of individual effort among these populations, in their own interest in the first place, by increasing production, thereby increasing their income, and also to ensure the subsistence of detribalized populations.

Within the framework of extensive agriculture such as we have described it, a first effort is necessary to alleviate work calling for considerable or long lasting effort. Careful consideration with the amount of work required for various types of production reveals that a first step can be accomplished by mechanizing certain operations in the early or later stages of cultivation, without modifying the principles of cultivation ensuring conservation of the

soil.

TABLE I . . Percentage of days of work required for hand cultivation of food crops in the Central Basin (forest) and in the Kivy (savannah Digitaria vâstita)

	<u>Central Basin</u>	<u>Kivu</u>
Preparation of the soil	3,5%	35,3%
Cultivation	14,8%	34,2%
Harvesting	17,1%	11,2%
Transportation	10,2%	6,1%
Preparation of products	54,0%	12,7%

The tests and first implementations were thus centred on transportation, clearing, and preparation of products.

The organization of transportation, not only within the community, but more especially towards transformation or consumer centres, has practically done away with long distance portorage. This evil of all primitive human organisation has disappeared with the extension of highways, roads and tracks accessible to wheeled vehicles and reaching all centres of population. For short distance haulage, the use of the wheel is encouraged; this was unknown before the arrival of Europeans and the uneducated native still finds it difficult to handle.

For clearing, more adequate tools have been distributed among the natives and this has constituted a first step in the way of progress. Modern methods are being popularized: felling with power driven saws and bulldozers, mechanical ploughs for savannah clearing. Trials so far effected show that it will be possible to integrate these methods into the organization of native cooperative societies.

According to their diet, natives often spend a considerable proportion of their activity to preparing their consumer products by hand; in forest areas more than 50% of their time is thus spent in preparing foodstuff consisting mainly in hydrocarbons. Some communities have been provided with mechanical equipment to shell, decorticate or grind products which were traditionally prepared by hand. The Government has recently provided rural communities with portable plants that can be taken from village to village, and equipped with crushers (palms), shellers (groundnuts) and flour mills. The operation of these mechanical plants is entrusted to native cooperative societies who place them at the disposal of the farmers against payment of small hire.

In the case of industrial crops, consisting in order of importance of oil seeds, palm fruits and groundnuts, and fibres, cotton and jute, the native farmer does not intervene after the harvest. The products are delivered in their raw stage to cooperative societies, to the trade or to industrial firms who take delivery at source, at minimum prices fixed by the Government. Cotton, however, remains the property of the grower until it is sold, for the processor merely acts as an intermediary between the producer and the consumer, against a fee fixed by the Government.

The object of these various measures is to relieve the farmer of part of his work. They have given good results, or will do so in the near future. However, continued use of mechanical equipment, even the simplest, will only become general by a gradual

process, for its operation calls for special training which is far from common in rural areas. Nevertheless, the day will come when, thanks to such equipment, the farmer will have some leisure, if he has produced enough to meet his needs, or will be able to increase his production if he wants to have additional income.

However, without changing the structure of our conservative agriculture, and without additional effort on the part of the farmer, its economic value may be considerably increased by using the soil in accordance with its vocation and cultivating those crops that are best adapted to it. I shall mention an example stresses the suitability of various soils in similar climatic conditions and points to a number of promising possibilities for the future.

Productions in kilo per hectare, in relation to types of soil at Yangambi.

<u>Types of soil</u>	<u>Crops</u>					
	<u>Groundnuts</u>	<u>Soya</u>	<u>Maize</u>	<u>Rice</u>	<u>Casava</u>	<u>Igname</u>
<u>Islands</u>						
Recent alluvia	1591	1360	2041	2624	-	+
Young alluvia	1473	990	1652	913	-	-
<u>Sandy lowlands</u>						
Lilanda grey sands	1394	394	2050	1390	16531	13568
Yambeles greyish brown sands	1063	374	1548	1233	13795	17920
<u>Highlands</u>						
Sandy clay soils on the plateaux - sol type	749	430	1141	2144	22297	13706

If we leave out the islands which constitute a special case, consideration of these figures shows that we can expect a marked increase of income, reaching as much as twice the present income, by adapting crops and rotations that are appropriate with this soil. At Yangambi, the sandy lowlands are suited to the production of groundnuts and maize, the highlands are better suited to rice and casava. It is therefore necessary that once the types of soil had been determined, their possibilities could be defined experimentally and the areas be circumscribed by carefully planned soundings. These various improvements do not call for any essential change in the system of cultivation which, I willingly agree, still follows primitive principles. If in the course of this exposé I have not referred to longer term views, you might say that I was unduly obstinate and backward in my conservatism. But such conservatism is just as much anachronism in the agricultural field as it has become in the human field.

Thus have I come to consider agriculture in the future where cycles of cultivation would be increased and periods of fallows shortened or suppressed by the rational and persistent use of mineral fertilizers, and where all, or nearly all the work would be effected mechanically, where unproductive and uncultivated soils would be replaced by productive fallows, thanks to animal husbandry, or by means of irrigation when necessary by reason of climatic conditions.

When you have visited a few areas of this country and seen for yourself the state of evolution of the population, some of you will probably feel that this is utopic. But even if this were the case

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is one not permitted to dream if it be for the purpose of improving the condition of one's fellow creatures. Past experience entitles me nevertheless, to consider the future with some optimism, for I am confident in the possibilities of the African race. If we consider the progress accomplished during the last half century, every hope is permitted. Why should we not hope to train farmers who would be receptive to progress, considering that some of them have become engine drivers or motor vehicle drivers, craftsmen in iron and wood, conscientious clerks, priests, and very soon agronomists and doctors of medicine. It rests with the Europeans whose part is essential in the education and training of these people, that some day, maybe in the distant future, these hopes become realized.

Before burning our offerings that we have, so far, accumulated on the altar of the god of soil conservation, before reversing our systems of cultivation or introducing new methods diametrically opposed to those that we have advocated so far, there is one means that has been scarcely tried yet and which is most promising: mineral fertilizers. These raise a technical and economic problem, however. Beside some spectacularly successful results achieved with certain crops grown on particular types of soil, trials with mineral fertilizers have often been disappointing, be it only from an economic point of view. Among the causes of failure, we must certainly bear in mind the particular behavior of fertilizers in tropical soils and particularly in lateritic soils, as you know: intensive leaching of the very soluble elements and immobilization of phosphate, but we must also blame an insufficient knowledge of the mineral requirements of the plants cultivated and the distribution of fertilizers which are sometimes more harmful than useful. The mould of application, the rate of distribution in relation to phases of vegetation are among other essential factors of an economic use of fertilizers. It has therefore been necessary to give further consideration to the problem of mineral fertilizers, and to lay down all the data of the problem in order to solve it. Physiologists, applying the theory of Professor Homès on balanced fertilizing, endeavour to determine, in a controlled medium, the mineral requirements of industrial and food crops. Already their work has thrown light on certain causes of failure in the past. Moreover, they have made it possible to establish formulae of balanced fertilizers, applied as such or adjusted to the requirements of the soil for the purposes of a given crop. Applications in the field are still too recent to draw a conclusion, but the first indications are encouraging, at least from a technical point of view. We now have to prove the economic value of such fertilizers and, in particular, to determine the conditions of application (doses, intervals of distribution, modes of application, etc) on which will depend the coefficient of utilization and the economic value of the method. These experiments in the field have been followed and completed by specialists in soil science. It rests with these latter to determine the requirements of the soil for a given crop, to study the effect of these mineral fertilizers on edaphic properties both physical and chemical, to calculate the coefficient of utilization by chemical diagnosis, etc. Finally, agronomists and statisticians plan tests applicable to various conditions of cultivation and rotation. It often happens, in fact, that the addition of a mineral fertilizer produces a beneficial effect only as an after effect. The rational utilization of mechanical equipment is particularly important in a country such as that where, owing to distances of transport, their price is high. Local production of nitrated fertilizer will be usefully studied in the future thanks to the considerable potentialities of hydroelectric power. The research for beds of potash and phosphate that are capable of exploitation will be pursued, although there may be but few definite indications so far available on the subject.

Mineral fertilizers might thus become the first element of intensification of our agricultural system, in the near future. They would make it possible to extend the cycle of seasonal crops, to reduce the heavy labour of clearing fallows and thereby increasing the productivity and the income of the farmer. Another way of intensifying agriculture and increasing the economic possibility of our rural populations, is to mechanise all or nearly all the work on the farm.

It was the only way of obtaining the full benefit of all the other improvements and increasing to the greatest possible extent the economic value of agriculture. Mechanization of agriculture also has a social aspect which should be the concern of every so-called "colonial agronomist", whose ideals should be of the highest humanitarian nature. By alleviating the work of the African and particularly that of his wife, the mechanization of agriculture can become the essential lever in the evolution of rural populations in the Congo.

I referred just now to certain mechanical methods, particularly in clearings, but it is our ambition to go further and to obtain more from mechanization. In order to apply such a programme the high priest of that god: "soil conservation" that I have been in the past must now become an apostate and burn all that to which I have knelt. Indeed, the very principle of our present methods of agriculture are incompatible with mechanization. How could we use mechanical equipment, particularly in forests, in a system of cultivation which is based on non-incineration, the retention of stumps, cultivation of large white ant hills, the absence of ploughing, delimiting of weeding, the protection of the soil by association of crops and finally, a natural and often arborescent fallow. Each of these factors has been recognized as important for the conservation or regeneration of soils in equatorial conditions and yet the mechanization of agriculture would entail that they all be abandoned, since each one constitutes an obstacle. How could one conceive an efficient utilization of agricultural machines on soil encumbered with tree trunks, stumps and ant hills? How could one handle associations of crops as varied as rice, maize, casava and bananas? In these conditions how are we to replace sowing and harvesting with machetes and hoes by mechanized equipment? The answer leaves no doubt: in the forest we must incinerate fellings, pull out stumps, and level ant hills, or else choose areas that are free of such obstacles, give up association of crops and finally, replace arborescent fallows by grass fallows or by improvement crops suitable to mechanised cultivation. Such is the problem. Now how to solve it? From the point of view of mechanical methods, quite apart from the economic point of view which has to be defined in each case, the problem can be solved, as has been shown by the first tests carried out by Governmental or private organizations. Mechanical equipment in the world is sufficient or will become so and existing machinery or machinery to be provided will permit of the application of these methods. Finally, mechanization does not necessarily imply the use of tractors. The replacement of arborescent or grass fallows by fodder crops opens the way to the raising of cattle bubals which can be used as draught animals in most agricultural operations.

From the point of view of agronomic methods, the problem remains to be solved, and I must be content with listing a few questions which arise at present:

What will be the incidence on subsequent crops of the packing of the soil by the heavy equipment used in clearing?

How shall one deal with the heterogeneous soil left by the pulling of stumps and the levelling of ant hills which leave in their wake extensive sterile areas?

What will be the evolution of the structure of a soil subjected to frequent ploughing and other cultivation techniques?

Will it be possible to maintain or to build up a favourable structure by means of improvement crops?

What cycles of cultivation and fallow will correct the consequences of pure cultivations, less efficient in protecting a soil which will become rapidly degraded, despite the application of mineral fertilizers?

What will be the evolution of the microflora of the soil after intensive incineration and application of such methods of cultivation, particularly in the case of permanent crops subjected to root disease?

How will the natural or artificial cover associated with perennial crops behave when submitted to mechanical treatment?

Such are the problems that our experts will have to solve, already, they have given them consideration. Their research work will be the basis of the development of this vast scheme which is to raise agriculture in the Congo to the level of more revolved systems where plant and animal products are associated.

Such projects raise an important problem of financing. The poor farmer that I have described to you is certainly not in a position to make a personal contribution. Such financing is a duty for the Government and for native associations. The first investment must come from official organizations for agricultural credit or reserve funds built up for the farmers. The equipment must be provided by cooperative organizations. The native farmer must merely pay for the mechanical work provided for him, at cost price.

In European agriculture, the development of mechanization will be dependent on costs and agricultural labour will be replaced by machines as soon as materially possible, economically valuable and free from harmful agronomic consequences.

With the realistic mind which, it seems, is a feature of the Belgians, the development of mechanization in native agriculture will be conducted cautiously. Repeated trials will be carried out, but the first applications will be limited to areas where geographic, agronomic and social positions are most favourable. It is necessary that the advantages of mechanization should appear, without any possible doubt to the eyes of native farmers who are naturally suspicious of any innovation. That scepticism which is common to all rural populations throughout the world, is particularly found among those whom that we are trying to take, without any transition, from the iron age to the age of the bulldozer. If they are to be convinced, the result must be spectacular, and that would be impossible in any but the most favourable starting conditions.

Among the methods of progress, there is one I have still to deal with: that of irrigation. Since the Congo territory is spread over both sides of the Equator, one might think there is no real problem of water supply. Nevertheless, it does exist, logically, in the most tropical areas with a dry season varying between 2 and 4 months, and exceptionally reaching 6 months, but it can also arise, quite unexpectedly, in the equatorial Basin. I referred earlier to the continental nature of the Central African climate, the consequence of which is an irregular distribution of rainfall. On the Equator, seasonal crops are impossible for 2 and sometimes 3 months in the year, owing to lack of water. It often happens that in a normal period of vegetation, plants suffer from a lack of water, the effects of which are the more serious that, in most cultivated soils, the water table lies at depths that are inaccessible to the roots. The practice of irrigation as a means of increasing productivity, is therefore justified even on the Equator where it must at least be tried out. In areas that have a definite dry season, its usefulness as a means of intensification is obvious. Unfortunately the geographical picture of the Congo does not present many large fertile alluvial valleys, lending themselves to the economic realization of vast irrigation systems. Despite these drawbacks, the possibilities offered by irrigation have not been overlooked and some realizations are already in progress and will be developed gradually.

modest though they may be at present, I will admit. In addition to problems appertaining to public works, irrigation will raise a number of difficulties that we can only guess at, not only in respect of the use of water in agriculture, but also and particularly in respect of the effects of irrigation on the evolution of the soil. Our experts will have to face these problems and the solution will be facilitated by technical assistance from the American Government who have placed at our disposal experts in these matters, as they have already done for the survey and mapping of soils.

If I have described our achievements to you with a degree of pride, I feel some anxiety however when placing before you our plans for the future. The problems which we still have to solve are vast and complex; our agronomists and our experts will have to devote all their abilities to solving them. But I feel sure that the communication put before this Congress and the exchange of view that will take place will bring to life new perspectives which will assist them in their task and you may leave the Congo with the conviction that you will have contributed to the progress of civilization in this country and with the improvement of the condition of the African farmer. You will thus have taken your share of that ideal that is ours.

Vè Congrès International
de la Science du Sol

Fifth International Congress
of Soil Science

Conférence Générale n° 2.

— LA CONSERVATION DES SOLS —

Ch.E.KELLOGS.-

Traduction française.

DEPARTEMENT DE L'AGRICULTURE DES ETATS-UNIS

Service de la Conservation des Sols

LA CONSERVATION DES SOLS.

Conférence de Mr. Charles E. Kellogg du Département de l'Agriculture des Etats-Unis, Washington, Etats-Unis d'Amérique, au cinquième Congrès International de la Science du Sol, Léopoldville, Congo Belge, Août 1954.

Maintes fois dans l'histoire de la civilisation, des moments sont survenus où l'homme a dû procéder à une réévaluation de ses objectifs et de ses possibilités. Nous vivons actuellement une de ces époques. Jamais civilisation n'a été confrontée par de tels problèmes. Des millions de gens commencent à se rendre compte qu'ils peuvent augmenter leurs ressources alimentaires, que la vie leur offre plus de possibilités, que de plus en plus ils peuvent façonner leur propre destinée.

Ce qu'il adviendra de la civilisation mondiale dans les années à venir dépendra dans une large mesure de la façon dont nous amènerons notre sol. De toute évidence, si nous voulons réaliser l'abondance dans le monde, il nous faudra récolter davantage sur les sols déjà exploités, en augmentant leur rendement, ou mettre en culture des sols actuellement en friche, et plus souvent combiner les deux.

L'abondance réside-t-elle dans nos sols? Si oui, comment la réaliser? A la première question j'ai répondu par ailleurs, affirmativement. (4) (6). Je voudrais aujourd'hui discuter de la deuxième: comment pouvons-nous atteindre et maintenir une production élevée?

Il est très facile d'être pessimiste, et beaucoup l'ont été. Mais si je reconnais volontiers l'énorme complexité du problème, et si j'admets qu'il ne faille pas insister sans cesse sur les difficultés, je n'en suis pas moins convaincu que nous devons penser et agir avec la plus grande énergie et d'une façon constructive, pour sauvegarder de ce qu'il y a de bon dans notre civilisation.

Sans une utilisation adéquate et un bon aménagement du sol, nous ne réaliserons pas l'abondance. Nous n'arriverons même pas à nous suffire. Mais le problème dépasse de beaucoup la seule science du sol. Il affecte presque toute notre structure sociale. Néanmoins, c'est par le sol qu'il nous faut commencer, le sol envisagé non seulement comme un phénomène naturel isolé, mais vu en rapport avec l'ensemble du milieu naturel et culturel de la production. Il nous faut

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WASHINGTON, D. C.

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aussi travailler pour réaliser l'abondance. Il nous faut aussi travailler pour réaliser l'équilibre entre l'utilisation des ressources et la population. Il nous faut particulièrement travailler pour assurer la liberté et la sécurité de chaque cultivateur.

DEFINITION DE LA CONSERVATION DU SOL.

Je n'ai pas encore employé l'expression "conservation du sol". C'est à cela, cependant, que je m'adresse. A l'origine, cette expression était fréquemment employée au sens étroit de la protection du sol, particulièrement contre l'érosion. La lutte contre l'érosion et contre les nombreux autres facteurs qui détruisent le sol fait partie de la conservation du sol. Mais les caractéristiques du sol que nous devons préserver sont également celles qu'il nous faut développer et souvent améliorer. Les méthodes qui restaurent et entretiennent le sol et celles qui assurent la production sont les mêmes. Elles sont inséparables et certes le cultivateur ne saurait les séparer. Le premier principe de la conservation qui ressort des plus récentes recherches et de l'expérience mondiale est que le succès exige l'application de méthodes multiples, adaptées aux différents types de sols. Une méthode unique ne saurait suffire.

L'expression "conservation du sol" comme nous l'employons maintenant est un terme positif. La conservation du sol comprend tout le système d'utilisation et d'aménagement dont dépendent le rendement, l'abondance et la continuité de la production, compte tenu des caractéristiques du sol et des ressources en eau des fermes, des élevages, des plantations, des villages, des exploitations forestières, et autres entreprises agricoles. Cela implique une utilisation sans cesse efficiente d'un sol toujours maintenu au meilleur niveau de productivité.

Dans un milieu économique et social favorable, l'adoption d'un bon système de conservation du sol par une famille d'agriculteurs repose sur trois principes essentiels: (1) la responsabilité des décisions doit incomber à la famille qui bénéficiera d'une assistance technique et s'appuiera sur les renseignements spécifiques qu'elle trouvera dans (2) une carte du sol et des explications quant aux différentes utilisations possibles, aux méthodes d'aménagement et aux rendements estimés des principaux types de sol pour (3) réaliser la combinaison de méthodes qui permettra de tirer le meilleur parti des données scientifiques et de toutes les ressources dont peut disposer la famille d'agriculteurs.

Nombre de conditions et de services essentiels contribuent à créer le milieu au sein duquel cette procédure que j'ai sommairement esquissée peut mener à des résultats profitables. Outre une base scientifique solide sur laquelle s'appuiera la technique, il faut au cultivateur des motifs pour adopter un meilleur système de conservation du sol, et la possibilité de l'appliquer.

Nous avons beaucoup entendu parler d'un "équilibre naturel" entre la population et les ressources. Si par là on entend le retour à un mode de vie primitif, autant renoncer à intéresser les populations. Ce que nous cherchons, c'est un "équilibre culturel" où l'homme pourra réaliser ses espoirs et ses possibilités en tirant le meilleur parti des moyens que lui offrent la science et la technologie.

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Cet équilibre cultural doit comprendre non seulement le sol et l'eau, mais aussi la force motrice, et les produits industriels qui permettront à l'agriculteur de donner toute sa mesure. Dans nombre de cas, l'énergie électrique et les engrais chimiques, pour ne citer que ces deux exemples, jouent un rôle aussi important que le sol lui-même pour assurer une production abondante tout en conservant le sol.

LE "SOL" ET LA "TERRE".

Ceci m'amène à considérer le "sol" par opposition à la "terre" (7).

En tant que néologues, c'est du "sol" que nous traitons, de cet ensemble de phénomènes naturels qui se présentent à la surface de la terre et qui résultent de diverses combinaisons de roche-mère, de relief, de climat, de matière vivante, et d'âge. Des sols de même type peuvent exister là où règnent des conditions économiques et sociales différentes, de sorte que leur utilisation et leur productivité diffèrent.

La "terre" est essentiellement un concept social et socio-géographique. C'est le milieu où se situe la production. La "terre" est un bien immobilier, une propriété. Les exploitations agricoles, fermes, élevages, plantations, etc., sont définies par des limites de propriétés, qui ne coïncident pas nécessairement avec les limites naturelles. Une "terre" est essentiellement caractérisée par sa situation. Des propriétés présentant un même sol peuvent être presque sans valeur, ou au contraire de très grande valeur, selon leur superficie, leur emplacement, ou leur aménagement. Certaines de nos meilleures terres agricoles, les plus productives au sens économique, présentaient à l'origine un sol naturellement infertile. Des millions d'hectares de mauvaises terres ne sont mauvaises qu'en raison de leur situation par rapport aux moyens de transport, à l'industrie, aux marchés, et aux autres facilités, en raison de leurs dimensions inadéquates, trop grandes ou trop petites, en raison du faible développement de l'agriculture dans la région. Ce n'est pas le rendement du sol qu'il faut incriminer.

En cherchant de meilleures méthodes pour augmenter la production, il faut retenir qu'une amélioration du sol n'apportera pas la solution si la production est limitée par quelque autre caractéristique de la terre. Des modifications apportées aux autres caractéristiques ne résoudront pas non plus le problème si le rendement du sol est mauvais.

Ces distinctions, déjà très importantes, sont appelées à devenir plus importantes encore. Le rôle que joue le sol dans la production agricole s'efface de plus en plus devant celui de l'industrie : les produits chimiques, la construction mécanique, la force motrice. Nous verrons des contrastes de plus en plus marqués entre parcelles de terre présentant des sols de même type.

POSSIBILITES DE PRODUCTION.

Une estimation des possibilités d'utilisation du sol doit comprendre à la fois les sols eux-mêmes et leur aménagement. Combien de fois n'a-t-on pas sous-estimé les possibilités de production d'une région simplement parce que les populations indigènes primitives ne

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10. *Chlorophyll a* and *Chlorophyll b* were determined using a spectrophotometer (Shimadzu UV-160U) at 663 nm and 646 nm, respectively. The concentrations were calculated using the following equations: $\text{Chlorophyll } a = 12.7 \times \text{OD}_{663} - 2.13 \times \text{OD}_{646}$ and $\text{Chlorophyll } b = 21.6 \times \text{OD}_{646} - 5.1 \times \text{OD}_{663}$ (Arar and Collins, 1997).

tiraient que de maigres récoltes de leur travail et de leurs méthodes. Ceci est particulièrement vrai dans les pays tropicaux. Et cependant, dans d'autres régions présentant des sols similaires, offrant les mêmes possibilités que celles cultivées par les indigènes, des records mondiaux de production ont été établis. Dans les sociétés primitives, seuls les sols ayant assez de dynamisme pour demeurer productifs peuvent être cultivés de façon ininterrompue et continuer à donner de bonnes récoltes. Il existe peu de tels sols dans le monde, que ce soit dans le pays tropical, ou ailleurs.

Les agriculteurs dans les sociétés plus avancées ne sont pas limités par la productivité d'un sol qu'ils se borneraient à labourer et à ensemençer. La qualité importante d'un sol est la façon dont il réagit à l'exploitation, la mesure dans laquelle il est possible de le rendre économiquement productif. La plupart des sols de l'Europe Occidentale et de la partie Est des Etats-Unis n'étaient pas naturellement fertiles. On les a rendus fertiles.

D'une façon très générale, on peut répartir les systèmes d'exploitation du sol en trois grandes catégories:

1) Les systèmes traditionnels, plus ou moins primitifs, élaborés en dehors de la science et de l'industrie modernes. Ces systèmes "indigènes" conduisent parfois, mais pas nécessairement, à l'appauvrissement du sol. Mais le rendement est généralement très inférieur à ce qu'il pourrait être. Une utilisation continue jointe à un rendement raisonnable ne se rencontre que dans un petit nombre de sols, dans le monde. Plus souvent, le sol est utilisé pendant de courtes périodes séparées par de longs intervalles de repos sous couvert végétale indigène, à moins qu'un appauvrissement grave ne mette complètement fin à son exploitation.

2) Les systèmes comportant des techniques dérivées de l'application de la science moderne, mais n'utilisant qu'un minimum de produits industriels, machines ou produits chimiques. Dans des régions en cours de développement mais encore à court de moyens de transport, d'industries ou de capitaux, c'est là souvent un stade intermédiaire. C'est-à-dire qu'en appliquant les principes de la science moderne, même sans avoir recours à l'industrie, le cultivateur habile peut obtenir une production sensiblement meilleure que celle de l'indigène et exploiter dans de bonnes conditions de rendement un sol que l'indigène aurait rapidement "épuisé".

3) Les systèmes d'exploitation à grand rendement qui font intervenir tous les moyens de la technologie moderne et utilisent au maximum les ressources de l'industrie.

Dans le cadre de chacune de ces grandes catégories s'insèrent nombre d'autres méthodes qui dépendent du milieu, de la technique et des ressources de l'exploitant.

Pour des sols similaires, la production et le rendement des cultures varient sensiblement selon les systèmes d'exploitation. Toute estimation de la productivité implique une étude des méthodes. Des systèmes primitifs, dans nombres de parties du monde, ont souvent été à l'origine d'une sous-estimation.

Nous avons examiné par ailleurs des estimations basées sur de bonnes exploitations, indiquant que l'on pourrait augmenter de quelque 50% les superficies économiquement exploitées, et de 20 à 50% le rendement des sols actuellement cultivés. (4) (13). Des chiffres plus récents,

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qui vous sont bien connus, nous font penser que ce sont encore là des sous-estimations. Et cependant nous voyons encore pénurie d'aliments dans certaines parties du monde et presque partout l'agriculteur mal payé de sa peine.

LE PROBLEME.

Cette faible productivité dans le monde en général, et les mesures contradictoires préconisées pour y remédier témoignent abondamment de la complexité et de la difficulté du problème de la conservation du sol. Je n'ai certes pas besoin de m'étendre sur le contraste entre les différents types de sols. Lorsque nous parlons de conservation, dans ce Congrès International, nous envisageons des milliers, des centaines de milliers de types de sols. Les caractéristiques qui affectent leur potentiel d'utilisation et leur comportement varient considérablement de l'un à l'autre, tout comme leur fertilité naturelle, leur réaction aux mille combinaisons de méthodes d'exploitation, et leur susceptibilité aux divers phénomènes destructeurs.

Bien que nous ayons beaucoup appris au sujet des sols et de la nature du problème fondamental de leur conservation, au cours des 50 dernières années, nous savons que nous avons à peine effleuré la recherche hautement spécialisée nécessaire pour les comprendre et pour développer une technologie efficiente. Faute de connaissances suffisantes, nous avons vu échouer d'importants programmes de conservation et de mise en valeur et nombre de régions privées du bénéfice de l'expérience acquise dans d'autres.

En lisant l'histoire de la science du sol, on constate que la principale erreur a consisté à rapporter les expériences et les prévisions à des caractéristiques isolées. Au cours des 20 dernières années, de réels progrès ont été accomplis et, de plus en plus, maintenant, nous nous rendons compte que l'influence d'une caractéristique donnée est liée à celle de toutes les autres. Nous savons que nous pouvons concevoir le sol comme un ensemble comportant de nombreuses caractéristiques. Nous avons appris que les principes de la dynamique du sol restent les mêmes, qu'il s'agisse de la mise en valeur ou de sa désintégration. Il est rare que nous ayons affaire à un seul phénomène dominant. Prenons l'érosion, par exemple: au cours des années, nous avons constaté qu'elle était infiniment liée aux changements dans les éléments nutritifs présents dans le sol, aux changements de structure et, d'une façon générale, à tous les phénomènes qui modifient de façon significative les caractéristiques du sol ou le développement et la densité du couvert.

Nous savons les limites étroites qu'impose un système d'exploitation unique. On peut évidemment citer des cas où l'introduction d'un système unique a donné de bons résultats, mais il s'agit là de sols relativement rares où toutes les autres conditions sont favorables. A mesure que nous progressons dans la technologie des engrais, par exemple, nous étudions de plus en plus les combinaisons d'éléments nutritifs et leur influence réciproque. (3) Il nous faut de plus en plus tenir compte des combinaisons de cultures, tant ce qui concerne les cultures mixtes que les assolements. En résumé, les observations récentes montrent clairement que les meilleurs résultats en matière de conservation du sol sont obtenus par des combinaisons de méthodes plutôt que par l'application spectaculaire de méthodes uniques.

La simple analyse du concept de la productivité nous le laissait du reste prévoir. Le sol a besoin d'air, d'humidité et d'éléments nutritifs en proportions adéquates. La plupart des cultures exigent un

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sol facile à drainer, qui absorbe l'eau cependant et la conserve d'une pluie à l'autre. Nous pourrions poursuivre longuement cette liste de facteurs qui déterminent l'abondance de la récolte en relation avec le travail fourni pour l'obtenir.

Certain d'entre nous ont essayé de diviser autrement le problème de la conservation du sol en posant, par exemple, cette question: peut-on répartir les facteurs d'appauvrissement en deux catégories, ceux qui ont des effets durables et ceux qui n'ont qu'un effet passager? Dans la première catégorie nous comprendrions l'érosion qui dévaste le sol jusqu'à la roche dure sous-jacente. Dans la deuxième nous rangerions, par exemple, le simple épuisement de l'azote auquel il est facile de remédier par un apport d'engrais azoté. Mais ce sont là deux extrêmes et fort peu de nos véritables problèmes peuvent faire l'objet d'une classification aussi simple. En général, nous observons des phénomènes concomitants. L'érosion, par exemple, va rarement jusqu'à découvrir la roche dure; mais elle peut découvrir des horizons inférieurs dont la productivité est difficile à maintenir. Le nouveau sol de surface est généralement dur à travailler. Avec des engrais, ou par d'autres moyens, nous pourrions peut-être restaurer la productivité primitive, ou même l'augmenter considérablement, mais au prix d'une main-d'œuvre et d'un matériel plus coûteux. Si on laisse un sol arable s'appauvrir en azote, ou en quelque autre élément, on déclenche le plus souvent un appauvrissement des autres éléments nutritifs et une détérioration générale de la structure.

Puisque nous ne pouvons pas diviser le problème d'une façon aussi simple, comment allons-nous déterminer les besoins d'un sol ou d'une région, au point de vue de la conservation? Théoriquement, nous pouvons envisager deux aspects du problème ainsi posé: (1) Que faut-il faire pour maintenir le sol dans son état actuel, ou pour l'empêcher de se détériorer?

(2) Que faut-il faire en outre, pour augmenter la productivité et le rendement afin de répondre aux besoins de la production agricole? A première vue, cette division du problème semble raisonnable. Il est certain que nous ne voulons pas voir le sol s'appauvrir davantage, et nous voulons l'utiliser au mieux, là où il est cultivé.

Mais c'est encore par trop simplifier le problème. Rare est le cultivateur qui puisse se contenter de demi-mesures destinées seulement à combattre l'appauvrissement du sol. S'il veut réussir dans son exploitation, il lui faut un système de conservation rentable. C'est-à-dire qu'il doit investir une main-d'œuvre et des matériaux tels qu'il obtienne une production suffisante pour la vente en même temps que pour les besoins de sa famille. S'il n'atteint pas un rendement de cet ordre, son système ne sera pas rentable du tout et il aura peine à se maintenir. Même une exploitation simple sera vouée à l'échec. Ainsi, dans la plupart des cas, il faudra avant tout déterminer si le sol se prête à une exploitation intensive en cultures de rapport. Dans l'affirmative et si l'on adopte la culture intensive, il faudra développer les méthodes assurant un rendement élevé, selon le type de culture choisie. Si le sol ne s'y prête pas, au contraire, ou si l'on ne peut trouver une méthode à rendement élevé, il faudra s'arrêter à un système d'aménagement extensif que le sol puisse supporter.

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Supposons pour le moment que nous puissions réaliser des méthodes adéquates pour déterminer les sols qui se prêtent le mieux aux différentes utilisations, et pour déterminer les combinaisons de méthodes appropriées à chacun d'eux, nous en sommes encore à la partie relativement simple du problème, qui consiste à faire admettre le principe de la conservation du sol. Il ne faut pas perdre de vue que, dans une société démocratique, les décisions sont prises dans le cadre de l'exploitation, par les fermiers, les éleveurs, les planteurs, les forestiers, les conseils de village, etc. Elles ne sont pas prises par les pédologues. La tâche du pédologue est de fournir à ceux qui doivent prendre les décisions (ou à ceux qui leur apportent une aide technique) les meilleures indications possibles, basées sur ses enquêtes, ses recherches, son analyse de l'expérience acquise dans les divers systèmes de culture. Tout chef d'exploitation agricole petite ou grande, est soumis à un grand nombre d'influences qui affectent ses décisions.

Le petit cultivateur qui essaie de passer d'un système d'aménagement non productif, ou non économique, à un système de meilleur rendement, se trouvera peut-être en présence de difficultés de caractère économique qu'il ne saura surmonter seul. Si ces difficultés ne sont pas résolues, notre technologie du sol, quelle que soit sa valeur, n'aura aucune chance de devenir effective. Si ardues que soient les problèmes techniques, je reste convaincu que les problèmes économiques et institutionnels sont encore plus difficiles à résoudre. Or, puisqu'il est essentiel de les résoudre et puisque notre oeuvre est si étroitement liée à leur solution, c'est à nous, pédologues, qu'en incombe la responsabilité, dans une large mesure.

Le problème fondamental consiste à aider le cultivateur à prendre ses décisions. La plupart des bons systèmes de conservation du sol exigent une préparation de longue haleine. Il faut aider le cultivateur à prévoir non pas un an, mais cinq ans, 10 ans, 15 ans même, à l'avance. Il faut d'abord, évidemment, fixer les données du problème. Il faut que le cultivateur se rende compte qu'il peut améliorer sa situation et qu'il veuille l'améliorer. Le problème doit ensuite lui être présenté sous une forme qu'il comprenne, or son langage n'est pas nécessairement le nôtre. Il faut encore qu'il possède la technique, la sécurité de tenure, le crédit, et toutes les autres facilités indispensables à l'application d'un bon système. Un facteur important est une saine économie nationale qui permette à l'agriculteur de se développer dans le cadre d'une agriculture florissante.

La conservation du sol apparaît ainsi, à juste titre, comme une tâche énorme. Et tout les éléments du tableau doivent cadrer. Mais si nous ne réalisons pas cette conservation, telle que j'ai essayé de la définir, nous verrons persister les périodes de famine ou de surabondance, l'appauvrissement du sol, le gaspillage d'efforts chez des millions de cultivateurs, et le découragement des populations rurales avec toutes ses conséquences politiques et sociales. Grâce à notre science du sol, nous savons qu'il n'y a là rien d'inévitable. L'abondance est dans le sol et l'homme peut modifier son économie et ses institutions s'il en a la volonté.

Je voudrais maintenant explorer dans les grandes lignes certains éléments primordiaux du problème, tels que je les conçois.

LA RECHERCHE.

Malgré ses réalisations surprenantes, la recherche en matière d'agriculture en général, en matière de sols en particulier, n'a rencontré qu'un minimum d'encouragement dans la plupart des pays du monde. Cette situation semble résulter de cinq facteurs principaux:

- (1) Nombreux sont ceux qui considèrent encore l'agriculture comme une occupation de statut social inférieur. C'est un point de vue très répandu, même parmi les agriculteurs. Dans certains pays, cette attitude s'étend jusque dans les Ministères de l'Agriculture, jusque chez ceux qui consacrent leur vie à l'agriculture professionnelle.
- (2) En contraste avec ses collègues des autres disciplines, l'agronome est sans cesse harcelé par ceux qui attendent de lui des résultats concrets immédiats. Aussi la recherche scientifique est-elle demeurée en arrière de la technologie. A long terme, cela se traduit par une perte de rendement.
- (3) Dans une large mesure, l'intérêt manifesté pour l'agriculture est centré sur certains produits spécifiques, au détriment des principes fondamentaux du comportement du sol et des rapports entre le sol et la végétation. Parmi les signes de cette tendance, notons le grand nombre de petits organismes spécialisés, ou centres d'essais consacrés à des cultures spécifiques, travaillant avec des moyens inadéquats.
- (4) Le coût des déplacements, les dérangements parfois, et le travail ardu que nécessite l'étude des sols, sur place, concourent à localiser à outrance et à déséquilibrer une grande partie de nos recherches. Bien qu'il faille user des laboratoires dans la plus large mesure possible, leur travail ne sera efficace que s'il est étroitement coordonné avec le travail sur le terrain.
- (5) Les recherches pédologiques ont été considérées comme presque exclusivement du ressort d'organismes subventionnés. En conséquence, peu de pédologues peuvent s'adonner aux recherches fondamentales qui sont l'apanage des universités subventionnées par des fonds privés, ou prétendre aux rémunérations élevées de leurs collègues scientifiques qui travaillent dans les laboratoires de recherche industrielle.

Ne voyez pas là l'expression d'un sentiment d'amertume ou de jalousie. Ce sont cependant des faits concrets qui soulèvent de graves problèmes de recrutement pour la pédologie et qui aboutissent à de sérieuses lacunes dans la connaissance scientifique essentielle si l'on veut atteindre des objectifs raisonnables en matière de conservation du sol.

Ce sont des obstacles qu'il faut d'abord identifier si l'on veut les surmonter. En premier lieu, en tant que pédologues, nous devons essayer de faire mieux avec les moyens dont nous disposons. Et les occasions ne manquent pas. Je voudrais esquisser brièvement les cinq programmes de recherche que je considère comme les plus urgents.

Premièrement, je voudrais souligner la nécessité d'un ensemble so-

lité de principes scientifiques qui ne peuvent émaner que de la recherche de base appliquée aux sols réels que nous possédons. Nulle part au monde ce besoin n'est plus urgent que dans les pays tropicaux. La découverte de techniques, ici pas plus qu'ailleurs, ne peut jamais précéder la recherche de base. Il nous faut connaître en détail les sols et leur comportement.

Deuxièmement, nous devons entreprendre des enquêtes sur le sol, dans toutes les régions offrant un potentiel d'utilisation. Les besoins et les méthodes ont récemment fait l'objet d'exposés détaillés. (9) (14) (15). Je voudrais seulement souligner trois points : (1) Les enquêtes rapides, et spécialement celles qui ne comportent pas une étude soigneuse des sols eux-mêmes, ne peuvent être que suspectes et de portée éphémère. Je vous accorde volontiers qu'il est beaucoup plus facile d'étudier des photographies aériennes ou des plantes au-dessus du sol, que d'étudier les sols. Mais il faut creuser la terre : c'est essentiel. (2) Le Service Pédologique, en tant qu'institution consacrée à l'étude des sols, doit avoir un mandat d'une portée assez vaste pour comprendre, d'une part, la recherche fondamentale sur la genèse et la morphologie du sol pour développer, d'autre part, une synthèse des résultats de la recherche et de l'expérience afin de formuler des prévisions précises pour l'utilisation et l'aménagement des différentes sortes de sols. (3) Les cartes et les textes explicatifs d'une telle Enquête Pédologique, solidement appuyés sur des principes scientifiques fournissent la documentation de base à nombre de fins et spécialement pour un programme de conservation du sol. Ou si l'on pose le principe en sens inverse, un programme de conservation du sol est un programme pour la mise en oeuvre des conclusions d'une enquête pédologique.

Troisièmement, il nous faut un programme de recherche en matière d'aménagement du sol, qui puisse développer des combinaisons nouvelles et plus efficaces de méthodes d'aménagement en vue d'une amélioration du sol et d'une production efficiente stabilisée à un niveau élevé. Dans une large mesure, notre effort actuel pourrait être rendu beaucoup plus efficace s'il était plus étroitement coordonné, tant avec la recherche de base qu'avec l'enquête pédologique. Bien qu'il soit utile d'essayer et de comparer des systèmes plus ou moins standard, spécialement comme un premier pas vers l'exploration de nouvelles régions, je suis convaincu qu'une imagination plus hardie peut nous conduire à des méthodes meilleures, entièrement nouvelles, qui feront entrer en ligne de compte les principes essentiels, non seulement de la science du sol mais aussi de la mécanique et des autres sciences.

Quatrièmement, je voudrais souligner le besoin urgent d'un plus grand nombre de fermes-pilotes (4) (5) (11). Par ferme-pilote, j'entends une ferme de recherche expérimentale où l'objectif est de trouver la meilleure combinaison (ou les meilleures combinaisons), de méthodes appropriées à la ferme considérée comme unité d'exploitation. Souvent, les savants mettent l'agriculteur, ou même l'agronome, en présence d'un grand nombre de recommandations non coordonnées, relatives à des pratiques isolées, laissant au cultivateur exploitant le soin de procéder aux recherches nécessaires pour les mettre en harmonie. Le plus souvent, ces recherches dépassent ses moyens, particulièrement en raison des graves risques financiers qu'elles entraînent.

Cinquièmement, et finalement, je suggère la nécessité d'apporter beaucoup plus d'attention à l'économie de la conservation du sol. Les données fondamentales émanent de tous les programmes de recherche ci-dessus, et de l'analyse d'exploitation existante. En prenant les valeurs quantitatives de récoltes obtenues avec des systèmes d'exploitation physiquement définis, sur des sols déterminés, il est possible d'établir des fonctions de production qui donnent une bonne indication des résultats économiques, dans différentes conditions de prix de revient. L'agriculteur tient à appliquer la combinaison de méthodes qui lui assure le maximum de revenus. Comme je l'ai déjà fait ressortir, la valeur d'un bon système de conservation ne peut être estimée qu'après un certain nombre d'années. En passant d'un mauvais système à un bon système, les dépenses dépassent souvent les revenus pendant les premières années. Puis, avec le temps, à mesure que le système devient plus efficace, le revenu augmente, couvre les frais et laisse un bénéfice.

Il nous faut reconnaître les caractéristiques de la courbe des coûts et de celle des revenus, ainsi que leur point d'intersection pour les différentes combinaisons de méthodes, sur différents types de sols. Ce n'est que sur la connaissance de ces courbes que le cultivateur peut baser ses décisions. Et généralement, il n'est pas seul en cause. Il a souvent besoin de crédit. Il incombe à quelqu'un d'évoluer, tant pour le cultivateur que pour son commanditaire, les possibilités économiques vraies de son exploitation. Je suis absolument convaincu que nos meilleurs systèmes de conservation du sol seraient plus généralement adoptés si leurs caractéristiques économiques dans les différentes conditions locales étaient analysées avec précision et si les résultats en étaient soumis aux cultivateurs et à ceux qui sont appelés à la conseiller.

L'EDUCATION ET L'ASSISTANCE TECHNIQUE.

De toute évidence, l'usage effectif de la technologie, en matière de conservation, exige du cultivateur qu'il apprenne de nouveaux principes et de nouvelles techniques, surtout s'il est appelé à prendre des décisions au point de vue aménagement du sol. Pour résoudre ce problème, il a intérêt à l'aborder sous deux angles tout à fait différents. Nous appellerons l'un "éducation" et l'autre "assistance technique".

Le premier pas consiste incontestablement à faire comprendre au cultivateur qu'il peut améliorer sa situation? J'estime, personnellement, que nombre de nos expériences d'enseignement agricole seraient plus efficaces si l'on insistait davantage sur l'instruction générale, sur la technique fondamentale de l'enseignement. Dans toute région, nous devons naturellement partir du point où sont actuellement les intéressés et commencer par souligner les valeurs culturelles existantes, consistantes avec un aménagement scientifique du sol, plutôt que par la négation directe de celles qui ne le sont pas, même s'il faut éventuellement modifier ces dernières pour arriver à de bons résultats.

Dans notre tâche de conseillers des cultivateurs, en matière de conservation du sol, nous pouvons clairement reconnaître certains principes et certaines méthodes qu'il est possible de généraliser,

Il est évident que la conservation des monuments historiques est une tâche complexe et nécessite une attention particulière. Les monuments sont des témoins de notre patrimoine et de notre histoire. Ils ont une valeur culturelle et scientifique inestimable. Leur préservation est donc une priorité pour toute société soucieuse de son avenir. Les monuments sont des biens publics et leur entretien est de la responsabilité de tous. Les pouvoirs publics ont le devoir de veiller à leur conservation et de leur assurer les ressources nécessaires. Les citoyens ont également un rôle à jouer en respectant les monuments et en contribuant à leur entretien. La conservation des monuments historiques est une tâche de longue haleine qui nécessite une collaboration étroite entre tous les acteurs concernés. Elle est une condition essentielle pour assurer la pérennité de notre patrimoine et pour transmettre notre histoire à la future génération.

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tandis que d'autres demandent à être élaborées spécifiquement, en rapport avec chaque unité agricole particulière. Dans mon pays, par exemple, nous avons donné à l'instruction agricole généralisée le nom "extension". Cette phase de travail est confiée à notre organisme coopératif, le "Federal and State Extension Service". L'assistance technique est du ressort du Service de la Conservation du sol. Ces deux organismes, naturellement, travaillent de concert et en collaboration avec les autres organismes traitant des autres phases du problème de la conservation.

Il est possible d'aider l'agriculteur à résoudre nombre de ses problèmes, grâce à un enseignement général adéquatement complété par des démonstrations en commun. Mais les problèmes individuels de l'adaptation de systèmes de culture visant spécifiquement la conservation du sol, au dispositif spécifique du sol et des ressources en eau et des propriétés individuelles ne peuvent faire l'objet de généralisations. Lorsque l'instruction a ouvert la voie, lorsque les communautés locales ont compris, ces problèmes d'exploitation individuelles peuvent être résolus un par un, propriété par propriété, afin de tirer le meilleur parti tant de nos sols que de notre technologie.

Pour donner de bons résultats, cette orientation individuelle doit commencer par une étude du sol de l'exploitation, en montrant les différents types de sols qu'on y rencontre et en donnant des explications tant sur leur adaptation aux diverses cultures et autres utilisations que sur les besoins d'aménagement en vue d'une production soutenue. Pour la plupart des types de sols, le cultivateur a plusieurs solutions possibles. Son choix dépendra de la superficie de la propriété de la main d'oeuvre disponible, de la technique de l'exploitant, et des autres caractéristiques de l'exploitation.

En commençant par une carte élémentaire du sol et en considérant les autres facteurs affectant le système d'aménagement, il est possible d'aider l'exploitant à élaborer un bon programme de conservation et de production, correspondant à sa situation particulière. De tels programmes exigent une certaine souplesse. Ils doivent évoluer à mesure que le cultivateur acquiert une meilleure technique et une plus grande expérience; ils doivent également évoluer avec les conditions économiques. Par dessus tout, ce système de programme doit aider l'agriculteur à tirer parti des principes scientifiques et de la technologie pour prendre des décisions et les mettre en oeuvre. Nous devons nous astreindre à augmenter sa confiance en lui-même lorsqu'il est appelé à prendre des décisions.(10).

Outre l'aide que nous lui apportons dans ce domaine, l'agriculteur a souvent besoin d'une assistance directe pour l'application de méthodes exigeant une technique spéciale qu'il ne possède généralement pas. A titre d'exemples, citons les essais de sols pour la détermination des principes nutritifs, les problèmes

tandis que d'autres demandent à être étudiées séparément.
en rapport avec l'agriculture traditionnelle. Dans ces
pays, par exemple, pour avoir donné à l'industrie agricole
généralisée la notion de "production". Cette phase de travail est
cette dernière, cependant, le "Producteur" est le "Producteur".
L'industrie traditionnelle est le résultat de la conservation
de ces deux organismes, notamment, travaillant de concert
et en collaboration avec des autres organismes existant dans d'autres
champs du problème de la conservation.

Il est possible d'obtenir l'agriculture à résoudre
ses problèmes, grâce à un enseignement approprié, notamment par
des démonstrations dans un domaine. Mais les problèmes individuels
de l'adaptation de systèmes de culture visent généralement la
conservation du sol, et c'est pourquoi les individus du sol et les ressources
sont en fait et des propriétés individuelles ne peuvent faire l'objet
généralisées. L'industrie traditionnelle a souvent la notion de
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culture a souvent besoin d'une assistance directe pour l'exploitation
de méthodes existantes, notamment, les méthodes de culture traditionnelle
sont à l'état d'urgence, alors que les sols de la zone de
détermination des principes traditionnels, les principes

de génie rural relatifs au drainage, aux cultures en terrasses, à la régularisation des torrents, à l'irrigation.

LE REGIME FONCIER.

Dans nombre de pays, le propriétaire doit assumer une plus grande responsabilité en ce qui concerne le bien-être du cultivateur qui n'est pas propriétaire de la terre qu'il exploite. La sécurité de tenure et une participation honnête à la récolte sont parmi les conditions essentielles d'un programme de conservation du sol. Le passage d'un mauvais système d'exploitation à un autre entraîne presque partout un programme à longue échéance. On ne peut demander au cultivateur de chauler ou d'amender un terrain, d'établir des lignes de niveau et autres dispositifs de régularisations de l'eau, de créer de meilleurs pâturages, ou de procéder à d'autres travaux du même ordre qui ne seront rentables qu'après un certain nombre d'années, à moins qu'il ne soit raisonnablement certain d'occuper encore le terrain pour recevoir sa part de la meilleure récolte, ou tout au moins d'être adéquatement rémunéré des améliorations qu'il aura apportées.

Le régime du fermage n'est pas nécessairement mauvais, mais l'application peut en être bonne ou mauvaise. Un système qui assure un revenu honnête au cultivateur-fermier rapporte également davantage au propriétaire, car une part modeste dans la récolte obtenue grâce à une culture conservatrice vaut généralement mieux qu'une part plus grande dans une récolte provenant d'un mauvais système, appliqué par un mauvais cultivateur travaillant dans l'incertitude de l'avenir.

LE REMEMBREMENT DES PROPRIETES DISPERSEES.

Dans beaucoup de pays, le problème de la tenure et de la faible superficie totale des propriétés est parfois compliqué par leur morcellement en minuscules parcelles dispersées. Au cours des dernières années, plusieurs pays, particulièrement en Europe, ont mis en oeuvre, ou tout au moins entrepris des programmes de remembrement des parcelles dispersées pour en faire des propriétés uniques, dans le cadre d'une législation spéciale. (1). De plus amples progrès s'imposent d'urgence car une meilleure utilisation de l'outillage et le développement adéquat de cultures mixtes avec longues périodes de jachère, ou d'assolements avec courtes périodes de jachère, sont généralement des éléments essentiels d'un système de conservation du sol. Avec les propriétés morcellées et dispersées, les réseaux routiers sont compliqués à outrance, il est impossible de surveiller les pâturages, il est difficile de réaliser de bons systèmes d'irrigation et de drainage.

Une double tâche incombe aux pédologues, en l'occurrence :

- (1) Ils doivent souligner la difficulté qu'il y a à appliquer à des propriétés morcellées des systèmes d'exploitation qui assurent à la fois la productivité et la conservation du sol.
- (2) Après un examen du sol, effectué avec précision et correctement interprété, ils devront élaborer un plan de remembrement équitable qui soit acceptable par le cultivateur et par le propriétaire.

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LE CREDIT AGRICOLE ET LA PARTICIPATION AUX FRAIS.

Pour mettre une nouvelle terre en valeur, ou pour passer d'un système de culture épuisant et de faible rendement à un système productif et conservateur du sol, il est souvent nécessaire d'engager des frais de main-d'oeuvre et de matériel qui ne seront récupérés que plus tard.

La rémunération intégrale peut se faire attendre pendant 5, 10, ou même 15 ans. Pendant ce temps, la plupart des cultivateurs ont besoin d'une aide financière directe. Ceux qui ont déjà fait la preuve de leurs capacités et qui possèdent un certain actif peuvent généralement obtenir des crédits, à des conditions raisonnables, du moins dans certains pays. Mais lorsqu'il s'agit du cultivateur dépourvu de moyens, qui doit améliorer sa technique pendant la période de transition, le problème est beaucoup plus grave. Il faut généralement une organisation gouvernementale du crédit, liée à des programmes pour l'intégration étroite du crédit et de l'assistance technique sur place. Ni le crédit, ni l'assistance technique ne peuvent réussir isolément.

A mesure qu'augmente la productivité de la communauté agricole, toute la société en bénéficie. Toutes les sources de revenus augmentent. En outre, le public a un rôle important à jouer dans le développement à long terme; il doit aussi être tenu largement responsable de la détérioration des ressources du sol. Dans bien des cas, il est juste que l'ensemble de la société contribue largement aux dépenses engagées. (8). Outre les facilités de crédit qu'ils peuvent donner, les gouvernements sont souvent fondés à accorder des subventions directes aux agriculteurs pour couvrir une partie des frais.

Ici encore, les pédologues ont une responsabilité particulière. Il leur incombe d'étudier et d'expliquer les possibilités de production à long terme et ainsi de fournir une base solide sur laquelle s'appuieront les programmes pratiques de crédit et de participation aux frais, essentiels à la réalisation de ce potentiel, dans l'intérêt général.

LES MARCHES ET LES COURS.

Je veux seulement parler des marchés dans la mesure où ils constituent un facteur essentiel de la conservation du sol, et pour souligner l'importance croissante des coopératives agricoles dans la réalisation des objectifs de la science du sol.

Si le rapport entre le prix de revient et le prix de vente est élevé, le cultivateur sera peut-être dans l'impossibilité de maintenir ses méthodes conservatrices du sol. Lorsque les prix de vente sont bas, le cultivateur néglige d'employer les engrais et les machines nécessaires à la conservation. Par contre, lorsqu'ils sont élevés, il est enclin à trop labourer et à trop semer, souvent dans des sols inappropriés. En fait, il est peu de facteurs qui soient aussi néfastes pour la réalisation d'un programme de conservation du sol que des cours soumis à de rapides fluctuations. Je souligne ce fait car certains considèrent la conservation du sol et la stabilité des cours d'es produits agricoles comme des problèmes différents. C'est peut-être vrai jusqu'à un certain point, mais ces problèmes n'en sont pas deux.

Pour mettre une exploitation agricole en valeur, il faut d'abord améliorer le sol. C'est la base de toute culture productive. Les engrais chimiques et les engrais naturels sont les deux moyens les plus efficaces pour atteindre ce but. Les engrais chimiques sont les plus rapides, mais ils sont aussi les plus coûteux. Les engrais naturels, comme le fumier, sont plus chers, mais ils sont aussi plus efficaces à long terme.

La répartition des engrais doit être faite avec soin. Il faut d'abord améliorer le sol, puis les cultures. Les engrais doivent être appliqués à la fois au sol et aux cultures. Les engrais chimiques sont les plus rapides, mais ils sont aussi les plus coûteux. Les engrais naturels, comme le fumier, sont plus chers, mais ils sont aussi plus efficaces à long terme.

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LES ENGRAIS ET LES PRAIRIES

Les engrais sont les produits qui améliorent le sol et les cultures. Ils sont classés en deux catégories : les engrais chimiques et les engrais naturels. Les engrais chimiques sont les plus rapides, mais ils sont aussi les plus coûteux. Les engrais naturels, comme le fumier, sont plus chers, mais ils sont aussi plus efficaces à long terme.

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pas moins étroitement liés.

L'UTILISATION COMBINÉE DES RESSOURCES.

La conservation moderne du sol dépend de plus en plus des produits de l'industrie, tels que les engrais, les machines agricoles, la force motrice. Lorsque les combinaisons de méthodes appliquées au sol par le cultivateur sont adéquatement équilibrées, le rôle du sol dans la production diminue, celui de la main d'oeuvre spécialisée et du matériel augmente. Ainsi, une bonne utilisation du sol exige des conditions d'emploi satisfaisantes, tant à la campagne qu'à la ville, et un équilibre raisonnable entre l'industrie et l'agriculture.

De plus en plus le progrès dans la conservation du sol dépendra d'un progrès parallèle dans l'utilisation et le développement des autres ressources, spécialement de l'eau et de la force motrice, ainsi que de l'ensemble des moyens nécessaires aux transports, à la santé et à l'éducation.

Nous ne pouvons entrer ici dans le détail des nombreuses façons dont l'utilisation combinée des ressources peut-être assurée au mieux dans les différentes régions. L'Administration de la Vallée de Tennessee, aux Etats Unis, est un exemple d'un organisme gouvernemental national prenant une initiative en pleine collaboration avec les autorités locales et les organismes privés. L'Union Minière du Haut Katanga, au Congo Belge, est un exemple d'une grande organisation privée dans laquelle des représentants du gouvernement prennent part aux décisions. Le choix de l'organisation qui assurera au mieux l'utilisation combinée des ressources d'une région dépend des conditions locales. Un de ces facteurs, et non des moindres, est le système de culture existant qui servira de point de départ. (4) (12). Autrement dit, le fait qu'un système fonctionne bien dans un pays ne signifie pas nécessairement qu'il soit applicable dans un autre, alors même que les ressources physiques soient de même nature.

En décrivant le potentiel de production du sol dans de nouvelles régions, il faut souligner qu'il reste peu de régions dans le monde qui se prêtent à la colonisation individuelle sur le modèle de la colonisation du 18ème et 19ème siècle. En d'autres termes, il reste peu de sols dans le monde qui n'attendent que le colon et ses outils rudimentaires. Cependant, nous avons un gros potentiel de production à développer si nous organisons l'utilisation combinée des ressources: agriculture, mines, industrie. J'ai l'impression que ce pays où nous nous trouvons, le Congo Belge, offre un excellent exemple de ce potentiel.

LE ROLE DES GOUVERNEMENTS.

Je crois que nous serons d'accord pour reconnaître que la responsabilité de la conservation du sol doit incomber en premier lieu au cultivateur individuel. Toutefois, une analyse des éléments du problème établit très clairement que le gouvernement doit assumer une large part de cette responsabilité, afin que le cultivateur puisse adopter une

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politique d'exploitation à long terme et appliquer la technologie à son entreprise d'une façon efficace. Et puisqu'il s'agit d'importants problèmes nationaux, régionaux et locaux, toutes les sections de l'administration doivent prendre une part active à la conservation du sol. A première vue, il pourrait sembler que l'intervention d'un si grand nombre d'organismes va compliquer notre problème de conservation. Certains pourraient même dire qu'il vaudrait mieux concentrer la responsabilité sous la forme d'un "programme national" énergique et de programmes non moins énergiques à l'échelon "province" et à l'échelon "local" ou échelon du "village", et ainsi "éliminer les doubles emplois et le chevauchement des responsabilités". J'aimerais réfuter un tel argument. Si nous ne mettons pas en oeuvre les parties du programme qui incombent à chacune des sections de l'administration, nous ne pourrons pas coordonner nos propres objectifs avec ceux des populations et nous n'arriverons pas à équilibrer les investissements publics pour la conservation du sol avec les autres investissements pour la santé, l'éducation, les transports, et autres services similaires.

Le succès de la conservation du sol dépend d'une collaboration très étroite entre le Gouvernement et les populations directement intéressées. Les projets à la réalisation desquels la population ne contribue que peu, ou pas du tout, et qui ne lui laissent que peu de décisions à prendre, ont peu de chances d'aboutir. Une direction éclairée est tout aussi importante sur le plan local que sur le plan national.

Les associations spéciales créées par mesure législative sont couramment des moyens efficaces pour pourvoir aux services nécessaires à la conservation du sol. Afin d'assurer une utilisation combinée des ressources dans une région vaste, il peut être nécessaire de créer un organisme régional qui contribuera à développer toutes les ressources disponibles. Le drainage, l'irrigation, le contrôle des inondations, le développement de l'énergie hydroélectrique, par exemple, exigent souvent des travaux publics importants et coûteux. Il arrive souvent même que deux ou plusieurs de ces branches du génie civil soient appelées à intervenir ensemble. Une bonne utilisation jointe à une bonne conservation du sol exige une préparation soigneuse qui tienne compte du potentiel de production du sol et des besoins probables des cultivateurs individuels.

Ces projets demandent à être soigneusement mis au point en vue des buts spécifiques à atteindre, en prévoyant la collaboration des autorités locales sous des formes qui les renforcent plutôt qu'elles ne les affaiblissent. Ce point est très important. On ne peut préconiser ni la "centralisation" ni la "décentralisation" du Gouvernement, d'une façon générale. Certaines fonctions doivent avoir une portée nationale ou régionale. Mais dans la mesure du possible, les décisions doivent être laissées aux autorités locales et au cultivateur individuel. Il ne faut pas oublier que la force d'une démocratie à l'échelon provincial ou national dépend de sa force à celui des agglomérations et des communautés locales.

Dans mon pays, le plus grand nombre avant qui ait peut-être été accompli en matière de conservation du sol a été l'organisation de la conservation par régions, dans le cadre d'une législation d'Etat (provinciale). Ces lois varient généralement d'un Etat à l'autre, mais prévoient généralement que l'agriculteur local décide par un vote spécial s'il veut, ou non, un organisme régional pour la conservation du sol,

Le projet de loi sur la décentralisation, qui a été adopté par l'Assemblée nationale le 15 mars 1982, marque une étape importante dans la mise en œuvre de la loi de 1972 sur la décentralisation. Ce projet de loi vise à renforcer les compétences des collectivités locales, à améliorer la gestion des services publics et à favoriser le développement économique et social des régions.

Le projet de loi est divisé en quatre parties principales : la première partie concerne la décentralisation des compétences, la deuxième partie concerne la décentralisation des ressources, la troisième partie concerne la décentralisation des services et la quatrième partie concerne la décentralisation des infrastructures.

La première partie du projet de loi vise à renforcer les compétences des collectivités locales. Elle prévoit notamment la création de nouvelles compétences pour les communes, les départements et les régions. Elle prévoit également la suppression de certaines compétences des collectivités locales, qui seront transférées à l'État ou à d'autres collectivités.

La deuxième partie du projet de loi vise à améliorer la gestion des services publics. Elle prévoit notamment la mise en place de nouvelles procédures de gestion des services publics, la création de nouvelles structures de gestion des services publics et la suppression de certaines structures de gestion des services publics.

La troisième partie du projet de loi vise à favoriser le développement économique et social des régions. Elle prévoit notamment la mise en place de nouvelles procédures de gestion des services publics, la création de nouvelles structures de gestion des services publics et la suppression de certaines structures de gestion des services publics.

La quatrième partie du projet de loi concerne la décentralisation des infrastructures. Elle prévoit notamment la mise en place de nouvelles procédures de gestion des services publics, la création de nouvelles structures de gestion des services publics et la suppression de certaines structures de gestion des services publics.

organisme qui apportera une attention spéciale au développement de la conservation dans les fermes individuelles. Dans le cas d'un vote favorable, la région est organisée et la population locale choisit en son sein ceux qui feront partie de l'organisme directeur. Ainsi se crée un solide élément local de direction, en même temps qu'un organisme adéquat pour mettre à la disposition des fermiers les services d'organismes nationaux et provinciaux. (17) (18).

Des dispositions quelques peu semblables existent naturellement dans nombre de pays, pour assurer la conservation du sol, ou pour assurer certains services qui y contribuent, tels que le drainage, l'irrigation, le contrôle des inondations, la protection contre le feu, ou le contrôle des pâturages. (16).

Par l'intermédiaire des organismes gouvernementaux créés spécialement pour la conservation du sol, nous devrions appliquer des méthodes d'organisation, dans des formes qui s'harmoniseraient avec les autres éléments de la société et contribueraient à développer les possibilités et les responsabilités de chaque individu, dans la poursuite de trois objectifs principaux :

- (1) Entretenir dans chaque pays, entre l'utilisation des ressources, l'emploi efficace de la main-d'oeuvre, et la population, un rapport tel que l'augmentation de la production dépasse le rythme d'accroissement de la population.
- (2) Réaliser, dans le cadre de chaque région ou circonscription, une combinaison de l'utilisation des ressources qui assure le plein emploi des ressources et de la main-d'oeuvre.
- (3) Réaliser des conditions telles que chaque cultivateur puisse organiser et mettre en oeuvre les combinaisons de méthodes qui assurent le maximum de rendement à son labeur et à son intelligence, dans le cadre d'un effort à longue échéance.

Même dans les meilleures conditions, le total des échanges de produits alimentaires est très faible par rapport à l'ensemble de la production mondiale. En général, la population de chaque pays devra résoudre ses propres problèmes alimentaires, tout au moins dans les limites d'une union douanière. En fait, les échanges de données techniques, et spécialement les échanges de principes scientifiques à la base de la technologie, et le commerce des machines et matériaux essentiels à l'agriculture et au développement industriel joueront un rôle beaucoup plus important pour la production des denrées alimentaires que les échanges de denrées elles-mêmes.

LA MISSION DU PEDOLOGUE.

Les indications que nous donne la science du sol nous amènent à croire que, dans des conditions sociales et institutionnelles favorables, le monde dispose de ressources suffisamment abondantes pour pourvoir à ses besoins alimentaires, en appliquant des méthodes

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efficaces de conservation du sol, et que ce résultat peut être obtenu par un petit nombre de cultivateurs, sur les sols dont nous disposons. Et cependant nous savons que nombre de cultivateurs sont pauvres et que le rendement de leur travail est mauvais, que les produits alimentaires font défaut en maints endroits, et que sur de grandes étendues la productivité du sol va en décroissant plutôt qu'en croissant.

Une lourde responsabilité incombe aux pédologues qui devront faire émerger l'abondance latente qui réside dans nos sols. La tâche qui les attend est difficile et complexe. Elle ne sera pas terminée tant que nous verrons des gens tirer leur subsistance du sol et demeurer pauvres. Elle ne peut naturellement pas être accomplie par les seuls pédologues; mais elle ne saurait certainement pas s'accomplir sans eux.

Les pédologues se sont assez mal acquittés de cette autre tâche qui consistait à expliquer au public la nécessité de fournir un effort constructif. Nous avons certes une littérature abondante sur les aspects négatifs du problème, particulièrement sur la détérioration du sol. Heureusement, la responsabilité n'en incombe que dans une faible mesure aux pédologues. Ce qui importe maintenant c'est un ensemble de réalisations régulières, compétentes, dans la voie beaucoup plus pénible des suggestions constructives et des améliorations.

Sans diminuer notre spécialisation (il faut même nous spécialiser davantage pour résoudre les problèmes de détail qui sont critiques), il nous faut élargir nos points de vue et envisager le problème de la conservation du sol dans son ensemble, afin que notre travail soit réellement efficace. Il nous faudra travailler avec les populations rurales, telles qu'elles sont, au sein de leurs problèmes persistants. Rarement aurons-nous l'occasion de tracer des plans sur une ardoise nette, dans une région complètement neuve et non développée.

Nous avons parcouru un long chemin depuis le premier de ces Congrès Internationaux de la Science du Sol. Nous avons fait les premiers pas dans la bonne voie. Le bien-être de millions d'êtres humains va peut-être dépendre de la façon dont nous nous acquitterons de notre mission, dans cette lutte de l'homme pour améliorer sa condition.

R E S U M E

Partant de l'hypothèse qu'il existe un potentiel de production non exploité dans les sols du monde, et d'une définition de la "conservation du sol" comme un système équilibré de méthodes pour assurer une production soutenue et un bon rendement, l'auteur décrit le problème général de la réalisation de la conservation du sol.

Il souligne la grande importance de la combinaison des méthodes en même temps que les rapports qui existent entre l'ensemble du problème et les services et dispositions essentielles qui permettront au cultivateur individuel d'organiser cette conservation. Ces moyens comprennent la recherche, l'éducation, l'assistance technique, le crédit, la participation aux frais, la sécurité du locataire, le remembrement de la propriété, la stabilité des cours, et le développement parallèle de l'industrie et des facilités pour l'éducation, la santé et les transports.

Fifth International Congress of Soil Science.
Leopoldville, August 1954.

AN EVENING OF CONGOLESE DANCING SPECIALLY ORGANIZED FOR THE
DELEGATES ON SATURDAY 21ST AUGUST 1954, IN THE PARK DE BOCK.

P R O G R A M M E.

Part 1. - Traditional Dances

1. The Women of the Wangata Dance.....the ESIOKOLOMBA.
2. The mixed group of the Basonge Batempa Dance...the KABUENKE.
3. The Women of the Busira Dance.....the TUKULU SUMBU.
4. The Bena Kondji Bakwa Tshika Dance.....the KONDJII WA BULOBA.

15 MINUTE INTERVAL.

Part 11. - Play and Distractions

1. The Bena Kondji Bakwa Tshika Dance.....the M'BWADI.
2. The Women of the Busira Dance.....the MBOLOKO
the INTE-INTE-OO.
3. The Basonge Batempa Dancethe MUKEMBELE SAMBU.
4. The Women of the Wangata Dancethe BONKOTO.

Special buses for this evening will leave the Athénée at 8 p.m.
and 9.30 p.m. and will pass by the Hotels about 9.30 p.m.

Description of the Congo Dances to be presented on Saturday 21st
August in the Park de Bock

Part 1. - Traditional Dances

The ESIOKOLOMBA is an excellent traditional dance of the Wangata, This is a women's dance which describes their work and daily life and was originally a study of woman's personality. The dance starts with an introductory movement called the LISAKO during which the dancers contact the spirits of their ancestors and present them to the public. After the introduction, we have a number of movements; the KOPEPA MBISI where we see the women fishing, their method being to draw the water from the river until the fish are no longer in their natural element, this being considered a typical feminine ruse used instead of more normal methods. In the KOLIA KWANGO, the women eat a plate of manioc without soiling their hands. The KOTAMBULA BWATU shows us the women in a native dug-out canoe using for paddle a wooden instrument which also serves as a knife or a spear. In the KOBUMA NIAMA the women are hunting deer using nothing but their feminine wiles and the harmony of their movements to catch the animal. After these different movements, the order of which is not established beforehand, the dancer dance individually to make a personal offering to the spirits of their ancestors and also to allow them to display their talents and the degree of perfection they have obtained.

The KABUENKE which is danced by the Basonge-Batempa is an even more typical example of the old Congolese school of dancing. The group consists of old and young women and the form of the dance is as follows: The dancers are in a single row with the old women at the head encouraging the young ones not to abandon the dance and to continue their teachings with the younger generation. The young women agree and dance to a directive chant of the old ones.

The TUKULU SUMBU danced by the Mongo and Busira women is the history of the perpetuation of the dance in fact, the dance of the dance itself. As in the previous dance, it is to allow the older women to instruct the younger ones. The Busira have developed this dance to the standard of a ballet, the adult dancers are visited by the spirits of their ancestors and show their pupils the quality of the old time dances. They advance towards their pupils and defy them to try and reach their degree of perfection. The pupils are then encouraged by the youngest dancer, a child of less than ten years, who leads the dance she must surpass the old ones in suppleness and control. This is a very serious part of the dance as it is considered a sacred rite in the cult of ancestor-worship. The dance ends with the applause and approbation of the old ones. The TUKULU SUMBU is very difficult to dance being a trial of virtuosity which must be perfectly executed.

The KONDJII WA BULCBA danced by the Bena Kondji Bakwa Tshika is the dance of the God of the Earth, the cult of Mvidi Mukulu the deity King Konji. It is a dance of praise dedicated to the illustrious Kondji. This is a very advanced form of dance having a choir, dancers and orchestra, the song is not spontaneous, the dancers are silent and are considered as taking part in a religious ceremony. Discipline, order and above all, authority are the principal elements of this dance and are in fact the outstanding characteristics of this warlike tribe.

Part 2. - Play and Distractions

The Bena Kondji Bakwa Tshika now dance the MWADI (the dance of the witch doctor) named for its creator Bwadi which is the custom for dances not subject to the presence of the spirits of ancestors. This is a modern dance and describes the former power of the witch doctor. The rites danced are to liberate the men from the spells cast by the women. The witch doctor, introduced as is his right by his myrmidon, frightens the women by chasing them with savage yells and also with a stick. Should a woman not be frightened, it is a sign that she does not accept the magical powers of the witch doctor an imprudence for which she pays dearly - with her life; the vengeance of the witch doctor being terrible and without pity. The "good old days" of the witch doctors are now but a memory, thanks to God and the Government.

The women of the Busira dance for us again with a more pleasing subject, the dance of the antelope, MBOLOKO. This dance describes the grace, the fragility and the timidity of the animal and is a very hesitant, calm and charming dance set to a gentle rhythm.

Next we have INTE-INTE-OO, a song of the wind where one or more dancers represent the reeds in the wind, a very ingenious and original interpretation.

A couple from the group Bosonge Batempa interpret the games of love and chance, a flirting dance known in the Kasai as MUKEMBELE SAMBU. In this dance, we see the timid lover being scorned by the object of his attentions, after which he becomes more daring and meets with success whereupon he pretends indifference and is duly pursued by the woman who loudly laments that she has discovered too late the danger of playing with fire. This dance has no fixed form and the scope of the dancers is practically unlimited. The whole point of the interpretation lies in its psychology and its comedy.

To finish, three women of the Wangata, painted red, show us the dance most loved by the Congolese, the BONKOTO, a picture of life and death - of the philosophy of movement and the magical powers of the dance. The story is a simple one. A young girl wailing alone in the forest is followed by a hideous witch who, jealous of her beauty, kills her. The knife with which the deed was committed fills the murderess with horror and remorse and she dances around the girl until the power of her dance enters into the body of her victim who then rises and joins her. This dance helps us to discover one of the vital principles of the native mentality. The Bantu considers movement as a sacred force which dominates life and the perpetuation of life.

Vth International Congress
of Soil Science

Vè Congrès International
de la Science du Sol

Inter-African Conference
of Soils

Conférence Interafricaine
des Sols

14

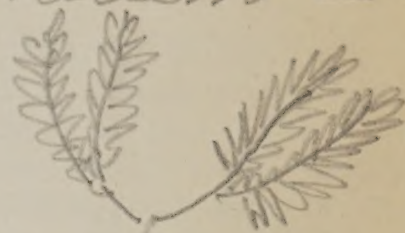
14

soil
ecology
in
A. Chantier



Lycopodium cernuum L.

Glechoma sp



Fourleaved
bracken

most Melastomaceae

EXCURSION I - BAS-CONGO

B. VISIT TO THE MVUAZI-KOKOZI FOREST RESERVE

Trichopteryx fruticulosa
'grass'

Document Anglais.

11-10-1944

1911

THE MVUAZI-KOKOZI FOREST RESERVE.

I. - INTRODUCTION

The object of this pamphlet is to provide the members of the International Soils Congress taking part in the Bas-Congo excursion with essential information on what they will be shown as they travel through the Mvuazi-Kokozi Forest Reserve.

They will take road from the Kiazi-Col railway station as far as the Mvuazi agricultural research station, following the Kokozi valley. On the way, they will see pedological profiles cut through various types of soil. At each site, they will have a brief summary of the geological, geomorphological, pedological and botanical conditions of the station. The order in which the various types of soil are described in this pamphlet is not the same as that followed during the excursion. A sketch gives the approximate position of the points of interest on this ten mile circuit.

II. - THE PHYSICAL ENVIRONMENT

1. Geography and Hydrography.

Pedo-botanical studies undertaken in this 70,000 acre hydrographical basin have provided the Government Departments and the Institut National pour l'Etude Agronomique au Congo Belge with the necessary information for the study of the sylvo-cultural and sylvo-pastoral scheme undertaken by the Mvuazi station.

The hydrographic basin of the Mvuazi and Kokozi valleys is situated at the extreme east of the Cristal range, in the shale and limestone area of the Territory of Thysville.

The rivers Mvuazi and Kokozi flow from the Inkisi-Kwilu watershed down to an alluvial plain where they join to run into the Kwili Madiata, one of the left bank tributaries of the Congo.

2. Geology and Geomorphology.

The Mvuazi-Kokozi Reserve is situated in the formations of the shale and limestone system. It includes the hydrographic basin of the Mvuazi river and its tributaries, the alluvial valleys of which cut through subhorizontal layers of fine limestone, of varying colour, containing cherts. The limestone overlies the shale. The latter is very fine; it varies in colour from purplish red to green; the formation is generally subhorizontal.

A few beds of oolithe are to be found between the limestone and the layer of sand covering the watershed of the hydrographic basins, to the north and east, and the isolated summits of the mountain range.

The difference in level between the valley and the highest points of the ridges is about 400 metres.

Erosion is still cutting into the divide line between the Mvuazi and Inkisi basins, in the eastern part of the Reserve. It is much less active in the western part where extends a wide alluvial plain.

Erosion has not been even and several surfaces are marked by terraces, signs of cyclic shelving, detrital deposits, etc.

The nature of the limestone substratum is indicated by the

appearance of features of the karstic cycles : dolines, resurgence, underground drainage, caves, soil collapse, etc.

III. - CLIMATE.

The climate of the Bas-Congo belongs to the Aw de Köppen type. It includes a dry season lasting, on an average, about 120 days at the Leopoldville longitude, and increasing, from north-east to south-west, to more than 160 days on the Atlantic coast. In the neighbourhood of Vuazi, it lasts on an average 130 days. In this area, it generally starts between the 20th and 30th May and ends around the 30th September. The annual rainfall is between 1400 and 1550 mm. There is a double rainy season, the maximum rainfalls occurring in April (300 to 350 mm) and in November (200 to 250 mm). The secondary minimum occurs in January (100 to 150 mm). At Vuazi, the mean day temperature of the air is around 23° to 26° C. during the rainy season; it drops to around 21° C. in the dry season. The temperature of the air can rise, however, as high as 35° to 37° C. and drop to about 10° C. in the dry season. The degree of undersaturation of the air varies only slightly in the course of the year. It is less than 1 mb. at 6 A.M. and reaches 10 to 14 mb towards 3 P.M. It should be noted that the severity of the dry season is tempered by the regular drop in the total incident radiation at that time of the year, due to reduced mean insolation at the limit of the atmosphere and to increased cloudiness caused by an influx of sea air. The annual average relative insolation is between 30 and 50 %.

IV. - SOILS.

The soils of the Reserve are derived from parent material produced by the weathering of chert limestone, shale or sandy deposits covering the upper ridges and isolated high summits.

This material has generally been transposed, either by alluviation or colluviation, or by the wind, by landslides or collapse, etc., and the resulting soils reflect the geological and geomorphological history of the area.

Alluvial deposits covering the older terraces are moderately deep, of light texture, yellowish in colour. Their chemical composition is comparatively poor. Recent alluvial deposits are deeper, of a heavier texture and rich in silt. They have a high cationic content, are generally porous, of sound structure, and of a brownish colour. Owing to their high content in available water, they are the best soils of the region.

The alluvial deposits of rivers originating from springs in the sandy region have a lighter texture than that of rivers which cut their way through the limestone and shale range.

In the same river, the texture of alluvial deposits becomes heavier downstream.

Soils from the limestone and shale areas surround the alluvial plains. The shale area is somewhat higher than the limestone area, nearer the periphery of the hydrographic basin.

The soils in these areas are very heavy, their structure is highly jointed, they vary in colour from brown to yellowish-red. They have a high water retention capacity, but sometimes lack porosity, particularly on the surface.

The soils of the limestone areas always contain chert. This comes from the leaching of the rocks and concentrates to form a stone line. The soils of the steep hill slopes generally have a diffuse stone line with cherts scattered more or less regularly throughout the profile. In the less hilly areas, the stone line forms a horizon 80 to 100 cm thick, where fragments of chert are mixed with detrited laterite. The stone line appears both in depth and on the surface and in the latter case it has an influence on the properties of the soil.

The soils of limestone origin are generally richer and have a better structure than those derived from shale, but this difference does not appear clearly owing to the presence of limestone-shale.

All these soils are quite resistant to erosion but once they do become eroded they lose much of their structure and are not easily restored.

Soils deriving from the sandy deposits on the high peaks are very different from all the other soils of the Reserve. They are to be found on the crests and on the higher isolated summits emerging from the surrounding relief. These soils are associated with a flat relief. They are of moderate structure, deep, of light texture, yellowish brown in colour. Their water retention capacity is comparatively low. This fault is counteracted to some extent by the fact that there is an underlying subhorizontal layer of shale not too deep down. These soils have a very low content in nutritive elements and very little resistance to erosion.

The following table shows the features of the soil series of the Reserve.

A. Zonal Soils :

- | | |
|----------------------|--|
| KIOWA Series | - Yellowish brown sandy soil, from the higher crests. Flattened relief. |
| MULU Series | - Soils originating from shale. No cherts. |
| NZANGI-NSANGI Series | - Reddish brown or yellowish brown heavy soils, having a jointed structure. Associated with a steep relief. |
| KIAZI-COL Series | - Soils originating from limestone, to be found on steep slopes, continually rejuvenated by erosion, of sound structure, brown in colour, with diffuse stone line. |
| LOMBO Series | - Soil originating mainly from limestone, thick stone line close to the surface. |
| мбака Series | - Same type of soil, but a flattened relief; deeper stone line. A heavy soil, brownish in colour, of jointed structure, with many dark infiltrations. |

B. Azonal Soils

- | | |
|---------------|--|
| BUNDU Series | - Old alluvial deposits, light in texture, moderately deep, weak in structure. |
| мвуази Series | - Fairly heavy alluvial deposits, of good structure. Rich brownish soil.
<u>Colluvial complex</u> of the hillsides - soils without any marked profile. Variable morphology according to origin. |

C. Intrazonal Soils

- Hydromorphic soil complex. Moderately, imperfectly and badly drained soils.

In their distribution over the area, the soils follow the order previously indicated (with the exception of the hillside colluvial complex) and taken as a whole they represent a CATENA.

D. Vegetation

The vegetation of the Reserve consists of scattered patches of forest, hemmed in by grass and wooded savannah. The savannahs are composed of several types of plant associations. Between the grass and the forest groups, various types of shrubs are to be found, in fallow or at various stages of restoration. The general process of evolution of the plant groups, from climax to anti-climax, takes the form of a series of more or less marked stages according to the greater or lesser resistance of the vegetation to the causes of evolution (type of soil, degree of erosion, slope, climate, human activity, etc.).

The succession of grass savannahs corresponds to well defined conditions of the pedological profile, the practical significance of which is expressed by their degree of fertility.

The vegetation groups represent entities. Each one can be considered as an integration of all the factors of the edaphomicro-climatic complex.

Generally speaking, the sandy crests are covered by a series of plant associations which are quite different from those of the heavier soils. Each savannah series, both in the sandy soils and in the clayey soils, consists of a sequence of plant associations exactly corresponding to the various stages of conservation of the profile.

Alluvial and colluvial deposits are covered with high grass. Very different forest formations are encountered on the sandy soil, the clayey soil, the alluvial or colluvial deposits, and the intrazonal soils.

The following is a brief description of the vegetation.

- | | |
|-----------------------------|--|
| Climax | - Forest of <i>Macrolobium cladantum</i> and <i>Randia octomera</i> .

This forest formation now occupies the heavy soils of the steep hillsides. |
| Paraclimax | - Forest of <i>Celtis mildbraedii</i> and <i>Staudtia gabonensis</i> . To be found on sandy soils in the form of isolated residual patches. |
| Rearranged forests | - Various forest formations are found here, from the climax type to the latest arborescent formations on soils in situ. |
| Riparian forest | - Forest of <i>Pseudospondias microcarpa</i> , <i>Celtis zenkeri</i> and <i>Dracaena capitulifera</i> .

Found on periodically inundated alluvial soils along the river banks. |
| Hygrophile and swamp forest | - Forest of <i>Mitragyna stipulosa</i> and <i>Marantochloa hensii</i> .

Grows on marshy intrazonal soils with a deep sheet of water. |

Riparian bushy vegetation - Consists of associations of *Mimosa pigra*, *Honkenya ficifolia*, and *Alchornea cordifolia*, to be found along the river banks and on soils frequently and periodically inundated.

Forest fallows - Various forest groups on heavy and light soils are characteristic of the state of exhaustion of the soil and of reafforestation of soils that have been abandoned after a period of cultivation.

Bush groups - Formations of savannah surrounding various groups of bush, according to the state of conservation of the profile and corresponding to the two main groups of soil texture.

Grass savannah - We shall consider these under two headings :
- The *Hyparrhenion corfinis* group :
- Association of *Andropogon gabonensis* and *Nephrolepis cordifolia*, on colluvial soils and on heavy soils with a well preserved profile;
- Association of *Hyporrhenia diplandra* and *Aframomum stipulatum* on heavy well preserved soils and on old alluvial deposits.
- The *Andropogonion schirensis* group :
- Association of *Ludetia*, *Arundinacea*, and.... *Landozphia lanceolata* on non degraded sandy soils.
- Association of *Hyparrhenia diplandra* and *Aframomum stipulatum*, sub-association of *Andropogon schirensis* on heavy soils at the early stages of degradation.
- Association of *Hypparrhenia lecomtei* and *Eupatorium africanum* on heavy soils in course of degradation.
- Association of *Andropogon pseudapricus* and *Sopubia angolensis* on heavy degraded soils.
- Association of *Anadelphia arrecta* on highly degraded heavy soils.
- Association of *Aristida Dewilde-manii* on degraded sandy or clayey-sandy soils.

Anti-climax - Association of *Elyonorus hensii* and *Crossopteryx febrifuga*, to be found on all types of soil at their last stage of degradation.

Grass savannah on excondated soils - Includes various associations of vegetation of rain swamps alternately inundated and excondated.

Aquatic or semi-aquatic vegetation of temporarily wet soils, dry and periodically inundated and excondated rocks, soft debris and animal resting places.

Herbaceous nitrophile, ruderal, cultural and post-cultural vegetation.

We shall only mention the two most extensive and most important of these associations :

- *Pennisetum purpureum* and *Hucuna pruriens* association, to be found on all heavy and light soils after forest fallow.
- *Pennisetum purpureum* and *Psophocarpus palustris*, a ruderal formation of large graminaceae to be found on recent alluvial deposits, periodically inundated.

This brief description of the vegetation is obviously incomplete. Further details will be found in the explanatory note accompanying the..... (?)

Corelation between Soil and Vegetation

Plant associations of the climax and anticlimax are the same for all series of soils. The first is represented by shady forest intermediate between the sempervirescent and the caducifoliate shady forest. The second is a highly xerophytic savannah association in the last stage of degradation.

In the intrazonal soils, of the hydromorphic complex, the corelations are excellent, easy to recognize and define. The other soils of the area have a plant cover which originated from the combined action of anthropic climatic factors and bush fires. This plant cover consists of two distinct types to be found respectively in the area of heavy soils or in that of light soils. Within these groups, a distinct corelation has been observed between the stages of soil degradation and phytosociological associations.

We shall only mention, as an example, the corelation existing between the soils of the Kiasi-Col, Lombo and Mvuazi soils and their plant cover, corresponding to stages of well preserved soil and of degraded soils. For details of the corelation between soils and vegetation, refer to the explanatory note accompanying the map of soils and vegetation of Mvuazi (Bas-Congo), by I. - Denisoff and R. Devred.

Kiasi-Col Series - Stage of good Conservation

This soil is associated with steep hill slopes. It derives from material produced by the leaching of chert limestone rock. It is deep, brownish, porous material. It contains fragments of chert scattered throughout the profile. The humid horizon of these soils is 15 to 20 cm thick. It is very dark grey in colour, and of good structure. It changes gradually to a clear brown, clayey, crumbly soil, of good structure, mixed with chert in lesser or greater quantity. These soils are highly resistant to erosion, in spite of the steep slopes. The pH is 5.5 to 6 and reaches 7 to 7.5 in the immediate vicinity of the blocks of limestone often found in the profile. These rocks are chemically rich and have a high water content. The high grass vegetation reaches 2.5 to 3.5 m. and belongs to the association of *Andropogon gabonensis* and *Nephrolepis cordifolia*, with a bush group of *Cussonia angolensis* above. This association is also found in the rich and well preserved soils of the area, such as the colluvial soils, and is characterized by a dominant herbaceous strata of high gramineae such as *Andropogon gabonensis* and *Beckeropsis uniseta*, and a lower strata of *Nephrolepis cordifolia*, *Sonchus schweinfurthii*, *Lactuca* sp. and *Crotalaria dic.sp.*

KIAZI-COL Series - Stage of High Erosion.

In its degraded stage, the humiferous soil is very much toned down and can hardly be distinguished from the brownish colour of the underlying soil. The structure becomes more massive, less porous,

particularly on the surface, the content in assimilable elements and the pH decrease; the soil becomes particularly deficient in water.

According to the degree of degradation of the soil, the Kiazi-Col series may have a cover of four plant associations of the *Andropogonion scherensis* group.

The most widespread association is that of *Hyparrhenia Lecomtei* and *Eupatorium africanum*, a grass vegetation reaching a height of 1.5 to 1.8 m.

LOMBO Series - Stage of Good Conservation

The soils of this series are generally associated with a hilly relief and steep slopes at the foot of the mountains. They are also found in the area of rounded contours in the lower plateaus. The parent material is characterized by a strong stone line consisting of chert with an admixture of detritic concretions.

The humiferous horizons of these soils vary from dark grey to brownish grey and they have a marked subangular structure. A stone line starts at a depth of 40 to 50cm, mixed with clay or with sand and clay, reddish yellow in colour, jointed and rich in dark infiltrations. Under the stone line, the material is often laterized. These soils are generally rich in phosphorus and potassium. The distribution of assimilable elements is typical; instead of being concentrated in the humiferous soil, they are regularly distributed throughout the profile.

The vegetation is mainly a savannah of *Hyparrhenia diplandra* and *Aframomum stipulatum*, with a sub-association of *Andropogon schirensis*. This association is also found in other types of heavy soils in a different state of conservation and consists mainly of *Hyparrhenia diplandra*, *Schizachyrium platyphyllum* and of the first elements of the *Andropogonion* group, such as *Andropogon schirensis* and *Eupatorium africanum*.

LOMBO Series - Stage of High Erosion

Erosion has removed the humiferous soil, except for that part which has infiltrated into the stone line. But this latter is also degraded : dark infiltrations are less abundant, the structure of the soil has deteriorated, there is sometimes excessive drainage.

The deterioration of the structure is accompanied by impoverishment in assimilable elements and in available water. The corresponding vegetation, and that which is most extensive in these conditions is the association of *Andropogon pseudapricus* and *Sopubia Angolensis*, or the *Anadelphia arrecta* association. These highly degraded associations are characterized in appearance by an upper and a lower loose herbaceous strata in which tufts of gramineae are widely spaced, sometimes leaving the soil bare or sparsely covered. These associations are also found on the Kiazi-Col type of soil in the more advanced stages of degradation.

MVUZAI Series - Stage of Good Conservation

The soils of this series are associated with the flat relief of the alluvial plain. They derive from a rich parent material deep, the structure of which varies from clay to sandy clay. The texture often varies in one and the same profile, from one horizon to another, owing to the heterogenous nature of the alluvial deposit.

This is a recent soil and its profile is therefore not clearly defined in genetic horizons.

The thick humiferous soil, blackish brown in colour, has a good structure and is rich in assimilable elements. It changes to a soil rich in alluvium, with a good structure, brown or yellowish brown in depth. It is a porous, well aerated soil, with good water retention. It is particularly rich in lime and organic matter.

We have not come across any of these soils in the highly eroded stage.

The characteristic vegetation of these recent alluvial soils is the *Pennisetum purpureum* and *Psophocarpus palustris* association. This association is practically monophytic and consists of a dense herbaceous strata 4 to 5 m high. It corresponds to the fluctuations of an underground sheet of water, of small depth, and to periodical inundations. If this latter condition were to disappear, the *Pennisetum purpureum* and *Psophocarpus palustris* association would be replaced by an *Andropogon gabonensis* and *Nephrolepis cordifolia* and by the *Cussonia angolensis* bush group.

I. Denisoff.
R. Devred.

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5TH INTERNATIONAL CONGRESS OF SOIL SCIENCE

Excursion 1 - Part 2

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24th August, 1954.

1. PRELIMINARY REMARKS.

Taking into account the length of the journey (87.5 miles), and being obliged to return to Matadi before the setting of the sun, Congress members are requested to follow punctually the following schedule:

Rising 6 a.m.

Breakfast on the spot 6.30 a.m.

Departure (hotel and ship)..... 7 a.m.

The Organizing Committee apologizes beforehand for not being able to wait for late-comers when the excursion leaves.

2. PROGRAMME OF THE DAY.

a) Morning

The road taken on leaving the right bank of the river, connects the Port of Matadi to the Port of Boma, passing by Gimbi and the Monsi. This road will be followed for a distance of 70 kilometers. At this point Congress Members will be able to see in this part of the "Centre Forestier du Mayumbe", under the control of the Forestry Services of INEAC, part of the 5,000 ha. of its sylvo-banana experimental Station. The stopping point chosen is also representative of the Mayumbe: a longitudinal profile of 250 metres has been established here.

b) Lunch

After this stop, Congress Members will be taken to the INEAC Station of Gimbi, where lunch will be served at 12.30 p.m.

c) Afternoon

The afternoon programme provides for a stop at a fertilizer experimental site on Sisal, as well as a visit to a quarry where lateritic concretions are extracted for the roads of the Station. At this point Congress Members will be able to see laterite in situ, as well as the parent material from which it was formed.

d) Departure from Gimbi

This is planned for 4 p.m., so that the crossing of the river may be done in all safety. Probably arrival at Matadi at 6 p.m.

3. DETAILS OF THE PROGRAMME

a) Journey: Matadi-Gimbi-Monsi.

From the right bank of the river, the road to Mayumbe runs parallel with a little torrent, which separates the Vivi plateau on micaceous quartzite from the Kionzo plateau on green rock. This green rock, formed from amphibolite lava, may clearly be seen near the landing-stage of the river. 5 kilometers further, the road, which winds round the plateau of Kionzo, reaches an alluvial bank, marked by perfectly rounded pebbles which come from an early river bed consisting of a cut off meander. A little below this alluvial level flows the Lufu river, over which the road passes on a 2-pillar cement bridge, 14 kilometers from its starting point. From here, the road rejoins the plateau of Sanda, a P₂B peneplain

(Pliopleistocene - Altitude 450 m) which, until it reaches the INEAC Station of Gimbi, is cut only by the M'Vuzi river.

On the slopes of the valley through which runs this river, reached after a journey of 28 km., are seen the banana cultivations of the Cobelfruit Society (370 ha).

It should be noted that the approach to the peneplain level is marked along the road by vast lateritic accumulations, the nature and the manner of formation of which will be studied at Gimbi.

42 km. North of Matadi the INEAC Station of Gimbi is reached. This Station, specialized in the study of fiber plants, is situated at an altitude of 480 meters. It has a climate with a long dry season, extending over a period of 5 months. The annual rainfall averages 1091 mm, with an average temperature of 24° 5'. The road to Mayumbe, running through the Station, is bordered on both sides with savannah in course of reafforestation as a means of protection against bush fires.

Beyond the Station of Gimbi, the road descends from the plateau, again cutting through a level of lateritic concretions.

From the commercial centre of Kinzao Vuete, (which has a dispensary for natives), the road from Matadi to Boma runs through an entirely different landscape from that observed up to this point and which is characteristic of the Mayumbe.

SOILS OF THE MAYUMBE.

The soils of the Mayumbe taken as a whole, result from alterations of rocks of pre-Cambrian origin, with local granit intrusions or covered with green rock.

The resulting soils are all the more different that, to those differences existing in the parent rock are added further differences arising from a relief in the process of evolution.

This incidence of relief on the general evolution of the soil of this region of the Congo is apparently due to a rather recent rising of the Mayumbe area.

The duality of influences (topographic and lithologic) is marked on any soil in situ, by a profile consisting generally in a variable thickness of loose cover resting on an intermediate stone line over a bed rock in course of alteration.

1. PEDOLOGICAL MEANING OF THE STONE LINE.

According to the localities, the stone line consists of quartz chips of different sizes in association with lateritic concretions, or by only one of these two types of components. In situ, it gives the appearance of a continued strip and a variable thickness over a relief now disappearing under the cover of loose material which it supports. Its existence to a certain depth under the present profile cannot be explained by an accumulation of the illuvial type.

As it does not present the characteristics of an alluvial or coluvial accumulation, we have tried to find an explanation for it by considering its formation in relation to the evolution of the Mayumbe during the pleistocene period.

This geological period was marked by the formation and subsequent filling up of a series of valleys, with a phase of tectonic movements (during the middle pleistocene) and is also distinguished by a succession of pluvial and interpluvial periods.

The combination of these phenomena accelerated the surface run-off of fine elements leaving in place only a layer of detrital material. At a more recent date this in turn was covered by a layer of loose run-off material.

Planting of vegetation does not impede the continuation of this evolution, which is still in process, because the present relief of the Mayumbe is far from having reached its balanced profile. This would explain the fact generally observed that soils covering

a stone line have on the surface a clayey fraction quantitatively less important than that which follows them in the same profile. To understand this it suffices to refer to the accompanying type analysis by C. KELLOGG. (Annexe 1)

2/ LONGITUDINAL PROFILE OF THE MONSI.

This profile, at a point particularly representative of the Mayumbe as a whole, is situated at an altitude of 265 metres. The region where this profile is established is constituted by the higher level of the Mayumbe system, represented between the Monsi and the Matsasia by the following formations:

- Slightly feldspathic micaceous chloritoschists
- Quartzitic Sericito-chloritoschists, biotite and muscovite
- Quartzitic micaschists, muscovite, chlorite and garnet
- Biotite micaceous quartzites
- Chloritoides phylladic sericistoschists (satined schists).

The longitudinal profile of the Monsi present the triple characteristic of the soils of this region, namely:

- 1) a loose surface cover,
- 2) a stone line
- 3) a basic formation in course of alteration.

The constancy of these characteristics which differ only by their thickness which can only be determined in a profile, renders their characterization especially difficult.

To enable us to draw up a diagram of investigation of these soils, we have attached to this note a cross section of the profile comprising 46 stations at equal intervals of 5 metres.

IMPORTANT REMARKS

The plan of the site of the Monsi profile, attached hereto, is accompanied by forms to be used for description of the stations of the profile. (Annexe II)

Copies of these observations will be gratefully accepted by the Organizing Committee of the Congress which will collect them and send them to those who have kindly assisted in this interpretation test.

c) Laterites of Gimbi

The laterites of Gimbi, whose characteristics and manner of formation are discussed in INEAC publication N° 60, can be seen in the form of concretions, in the limonite quarry on the road going from the Gimbi post to the M'Vuzi River. At this point they can be seen on a face 30 metres wide and 5 metres high.

In the trench opened up at the base of the concretions it can be seen that they are followed, without transition, by a clayey foundation of mottled clay scattered with lateritic granules in process of formation.

d) Experimental Fertilizing of Sisal at Gimbi

The excellent results obtained from the use of fertilizer on sisal, in the poor soil of the Gimbi plateau, results which appear in the outline of the Station's activities, led to converting the reproduction tests on sisal, planted in 1948, into fertilizer tests in 1951.

Samples compared to non fertilized controls are as follows:

Sample 1 : 1 ton lime per ha. per annum + yearly N.P.K. fertilizer

Sample 2 : 5 tons lime per ha. + yearly N.P.K. fertilizer

Sample 3 : 2 tons lime per ha. per annum + yearly N.P.K. fertilizer

Sample 4 : 10 tons lime per ha. + yearly N.P.K. fertilizer.

The yearly N.P.K. fertilizer includes: 90 Units Nitrogen, 30 Units phosphate and 130 Units potassium.

The present average yields for the various samples are:

Sample 1 : 58,4 tons of leaves

Sample 2 : 77,0 tons of leaves

Sample 3 : 75,9 tons of leaves

Sample 4 : 85,1 tons of leaves

Control 42,1 tons of leaves

It should also be noted that the quality of the fibers is in proportion to yields and that all symptoms of disease have disappeared in the fertilized samples.

ANNEXE I. - ANALYSIS OF RED LATOSOL (Luki-Mayumbe) - (C.E. KELLOGG & F.D. DAVOL)

Size Class and diameter of Particles (in mm) Other Classes in mm.)

Sample No	Horizon	Depth	pH	Organic Carbon	Very Coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	0.02-0.002	0.005	2	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
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Total Available P

Sum of % Cations Base Saturation

Exchangeable Cations me/100 g

Ca Mg Mn K H me/100 g

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Pct. ppm.

Description of the samples-

A ₀ and A ₀₀	Verythin	Brown organic remains	B ₁	13-19"	Yellowish-red (5YR 5/7) clay. Subangular medium nut.
A ₁₀	0-1"	Dark reddish-brown(5YR 3/4)clay Porous and easily friable to firm granular	B ₂	19-40"	Red to yellowish-red (2,5 YR 5/8 to 5 YR 5/8 Clay. Poorly developed blocky structure, firm and springy, but fairly friable.
A ₁₁	1-8"	Reddish-brown (5YR 4/4) clay. Well developed irregular nut, firm but friable -	B ₃	40-72"	Like above, except light red to reddish-yellow (2,5 YR 6/8 to 5 YR 6/8)
A ₃	8-13"	Many roots and insect holes Transitional	C ₁	72-80"	Mixture of light red to reddish-yellow clay and strongly weathered quartz pebbles and stones. (Probably less coarse material from fairly basic igneous rocks at great depth).

ANNEXE II

Name:

Congress N°:

Address:

Monsi longitudinal profile (Mayumbe).

Station N°

(indicate the red number on the plate)

QUESTIONNAIRE.

1) Do you know any soils equivalent to those of the Monsi?

Where can they be seen?

Who has already studied or described them?

2) How would you describe the profile before you?

3) How would you survey the soil of this region?

Correspondence No:

Name:

Address:

Mosses longitudinal profile (Mosses)

Station 10
(Indicate the red number on the plate)

QUESTIONS

- 1) Do you know any soils equivalent to those of the Mosses?
Where can they be seen?
Who has already studied or described them?
- 2) How would you describe the profile before you?
- 3) How would you survey the soil of this region?

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= EXCURSION I - LOWER CONGO =

- C! VISIT TO THE GIMBI REGION -

August, 24 - 1954

2. Notes on the forestry-banana tree programme

English document.

Note on the banana plantation programme

C. DONIS.

The banana plantation programme which was started in the vicinity of the site of the Luki excursion of the Fifth International Congress of Soil Science, consists of a method of treatment for the artificial regeneration of *Terminalia Superba* E and D (Limba, Korina) in banana plantations on land temporarily used for food crops.

This treatment achieves uniformity from the bottom (1) in rearranged heterogeneous forests.

The presence of a quick growing secondary social species of good appearance, the average condition of the natural forest and of the soils of the Mayumbe cristallophylian zone, on the one hand, and the combination of economic and geographic conditions and the system of land tenure in this natural area, on the other, have made the satisfactory application of this combined arrangement possible in State forests.

Natural forests.

The most widespread types of forest in the Luki area consist of secondary plantations of *Terminalia* having a high economic value, of rearranged heterogeneous forests of various ages, of plantations of *Gossweilerodendron Balsamiferum*, of plantations of *Xylopia* and of anthropic savannah.

A study of the forest, past and present, reveals the influence of ancient customary cultivation on the distribution and structural composition of the various types of forest. This influence has varied, both in intensity and in recurrence, and has led to a breakdown of the features of vegetation and pedology, so that the forest plantations have acquired some of the aspects of group cultivation.

Among these aspects, it should be noted that :

- accessible forests are composed of groups of trees, more or less of the same age, with the possible survival of older individual trees ;
- these groups, covering an area of 1500 to 2000 square metres, or even less, are irregularly distributed over some 50.000 acres of forest ;
- the pedological base of these groups includes very different stages of degradation ;
- the further a patch is from the centre of cultivation, the more the plantation differs from this structural type (group selection) and the nearer it comes to pure selection.

Where the soil is naturally not fertile, the high yield obtained by customary methods has led the natives to press for the resumption of farming. The result has been the establishment of extensive plantations of *Terminalia* and the exuberant development of *Scitamina* (*Sarcophrytnium Macrostachyum* Benth and *Maranthocloa Hensii* Bak. Pellegrin) propagated by cuttings at each new period of cultivation.

The evolution of the lower growth which is regularly cut at this stage has stopped the development of the upper growth. Artificial regeneration of *Terminalia* thus became necessary in order to ensure sufficient regularity without calling for an excessive amount of work or entailing too long a period of waiting.

Customary activity has led to a distribution of the various age groups around centres varying in numbers from 45 to 25 units. Since the object of the planning of this plantation was to establish a normal series of cultivation, it was necessary to avoid relating regeneration proper to the present exploitation of natural forest.

In the beginning, this entailed limiting regeneration work to such parts of the forest as provide the greater areas of workable plantations. In other parts, it will lead to inevitable sacrifices and it has been possible to apply uniformisation from above in the area to be regenerated at the cycle (2).

Geographical and economic conditions ; conditions of land tenure.

Rearranged forests in the cristallophylian area are the nearest to sea ports ; They enjoy tropical maritime climate ; it was therefore logical to apply them to permanent ligneous production of low value.

On the other hand, the cultivation of "Gros Michel" banana trees which was introduced before the war (3) seemed likely to show a period of prosperity in the years 1947-48.

Although positive results were achieved at the Mvuazi Station in certain conditions of intensive cultivation (4), cultivation of "Gros Michel" banana trees in forest areas on the hills of Mayumbe is still carried out according to the principles of extensive forest cultivation.

It appeared desirable to combine the compatible elements of two productions which were homologous in respect of value, of urgency of disposal, of the extent of land required and of the extensive conditions of establishment. The Committee of Management of INEAC took the opportunity.

This decision followed upon a series of experiments conducted at the Kondo Station since 1939, on the cultivation of banana trees, and upon the experience gathered in the extensive plantations carried out by the "Société Agrifor" at Lemba.

Not only did this combination achieve considerable economy of labour but also realized excellent conditions for the growth of the young trees. In addition, the necessary land for the normal service of a specialized shipping line was thus made available to the banana industry.

Methods.

Reafforestation in banana plantations which have occupied the land for five or six years is merely a particular application of the Taungya system first applied in Burma as far back as 1869 (5) for the regeneration of teak in temporary food crop cultivations. This system of reafforestation in fact amounts to applying customary methods to *Terminalia* forests.

After the banana plantation has been established, Terminalia plants are introduced in the form of half-stalks. When cutting down, the young groups of choice species are reserved.

Experience has shown that it was desirable to introduce forest plants during the rainy season that follows the establishment of the banana plantation, in order to avoid the severe conditions that prevail in cuttings.

In order to achieve greater regularity and to simplify the work of cultivation and of filling in the gaps, it was considered desirable to place the Terminalia at distances of 4 x 12 metres and to maintain the banana plants at a distance of 3 metres from forest plants.

Legal set up and present importance of the schemes.

The banana plantation scheme is financed from State funds. Its object is, therefore, the regeneration of State forests.

INEAC, which is a parastatal organisation, manages the scheme for the account of the Colony, in the experimental estate of Luki.

The first rights of temporary occupation took the form of private agreements governed by special rules in respect of the use of the land, the reafforestation and the implementation of agreements between INEAC and the banana planters.

This scheme was started in May 1948 and has so far been applied to some 10,000 acres of forest land, 5,000 of which are now cultivated.

Similar conditions apply to the scheme for the training of independent autochthonous farmers working on rented land.

In the forest reserves directly administered by the Colony, similar agreements are in existence for some 7,500 acres.

Future work.

The development of these regular plantations will have to be followed by special studies, particularly in respect of secondary accompanying vegetation which will develop as soon as the banana plantations are abandoned; this applies specially to species in competition with Terminalia (liana, cerba) and to the natural ~~xx~~ regeneration of precious species.

Finally, there exists an additional agricultural possibility due to the fact that this forest area includes a proportion (about 10 %) of particularly fertile soil belonging to the Red Latosol group (6). INEAC is considering the ways and means of applying some of these soils to the cultivation of cocoa in the shade of forest plantations established under the banana-forest scheme.

After the banana plantation has been established, Terminalia plants are introduced in the form of half-saplings. When cuttings are taken, the young groups of Terminalia plants are reserved.

Experiments have shown that it was desirable to introduce forest plants during the rainy season that follows the establishment of the banana plantation, in order to avoid the severe conditions that prevail in outcrops.

In order to achieve greater efficiency and to simplify the work of cultivation and weeding in the gaps, it was considered desirable to plant the Terminalia at distances of 4 x 12 meters and to maintain the banana plants at a distance of 22 x 22 meters from the forest plants.

Local set-up and present importance of the banana plantation scheme.

The banana plantation scheme is financed from State funds. Its object is, therefore, the regeneration of State forests.

INMAG, which is a parastatal organization, manages the scheme for the account of the Government. The experimental estate of Leki.

The first right of forestry acquisition took the form of private agreements governed by special rules in respect of the use of the land, the reforestation and the implementation of agreements between INMAG and the banana planters.

This scheme was started in May 1962 and has so far been applied to some 10,000 acres of forest land, 2,000 of which are now cultivated.

Similar conditions apply to the scheme for the training of independent autonomous farmers working on rented land.

In the forest reserves directly administered by the Colony, similar arrangements are in existence for some 7,500 acres.

Future work.

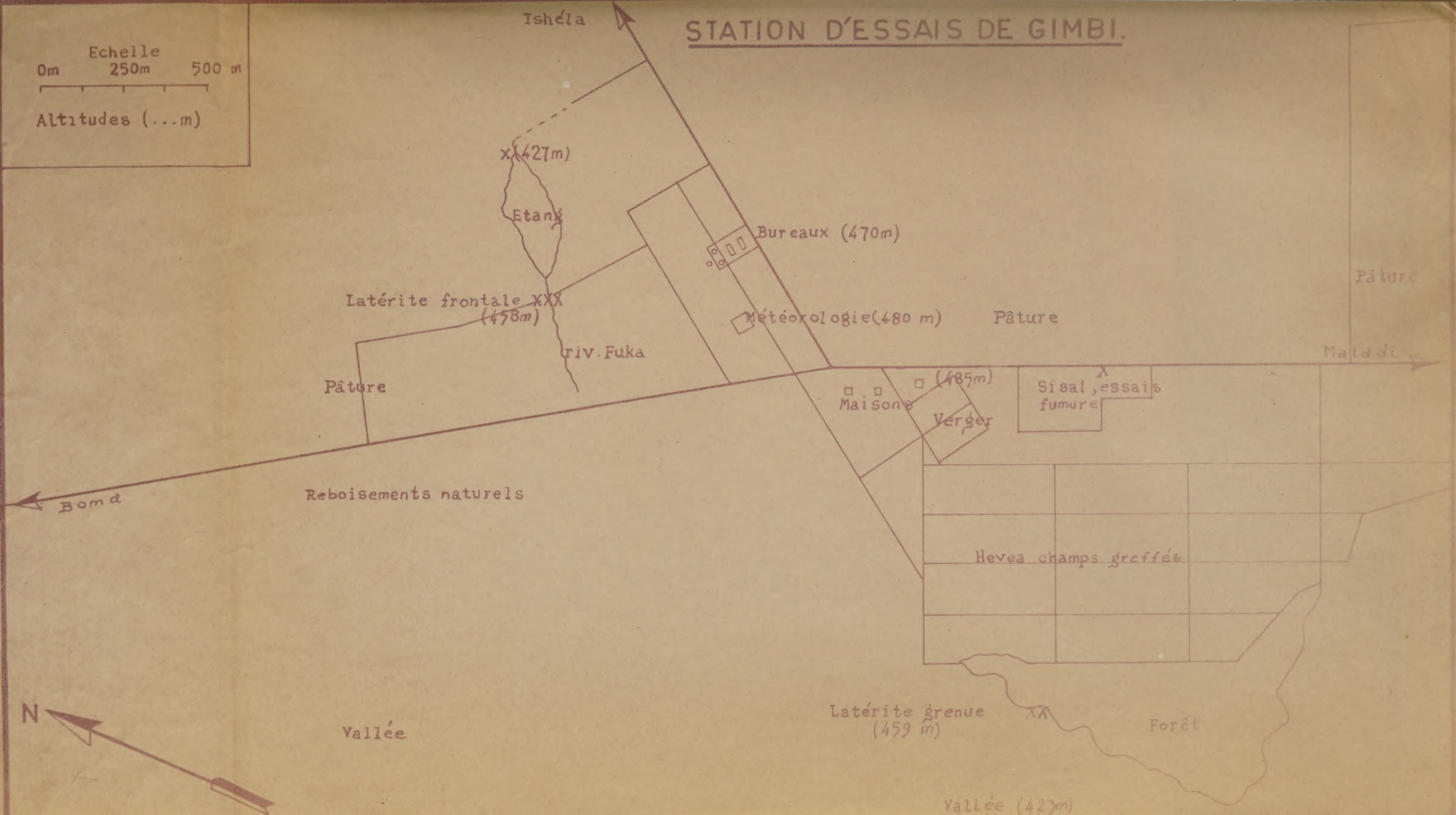
The development of these forestry plantations will have to be followed by special studies, particularly in respect of secondary succession, vegetation which will develop as soon as the banana plantations are abandoned. This applies especially to species in competition with Terminalia (Liana, nipa) and to the natural vegetation of previous species. It is possible that the Terminalia and a proportion (about 10%) of the forest plants belonging to the Terminalia group, which are the ways and means of applying some of these soils to the cultivation of areas in the shade of forest plantations established under the banana-forest scheme.

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STATION D'ESSAIS DE GIMBI.

Echelle
0m 250m 500 m
Altitudes (...m)



Vè Congrès International
de la Science du Sol

Vth International Congress
of Soil Science.

Interafrican Soils
Conference

Conférence Interafricaine
des Sols

EXCURSION I - LOWER-CONGO

C. VISIT TO THE GIMBI REGION. -

August, 24. 1954.

3. Activities of the research Station at Gimbi.

ACTIVITIES OF THE RESEARCH STATION AT GIMBI.

Director : Mr. OLDENHOVE de GUERTECHIN, H.

Assistants : Mr. BLONME, A.
Mr. CASTIAUX, J.

Adjuncts : Mr. VAN HOEF, J.

The Station, which was founded at the end of 1939, is situated on the right bank of the Congo river, at 44 km from Matadi, along the road Boma-Matadi.

The Station lies on a poor savanna upland which is cut by more fertile valleys.

The plateau soils consist of compact, red or yellow coloured clays, which are underlain, at a small depth, by a layer of lateritic gravel. A limited part of the Station lies on sericito-chloritoschists.

The research work on fibre and food crops, which constitutes the major activity, takes place in those two conditions which are representative for the region.

SISAL.

Cultivation trials showed that Agave sisalana is the highest yielding species and emphasized the necessity of fertilizer use in degraded savanna soils.

The following yield data (in kg products per hectare) indicate that fertilizer application may offer interesting economic prospects in poor upland soils :

(s. following page)

These data, excepting those of treatment i, were obtained in experiments on savanna soils.

The mineral fertilizer consists of 400 kg of potassium chloride, 80 kg ammonium sulphate and 80 kg bicalcium phosphate.

Fertilizers, compost and much were applied during four years (1948 to 1951) and lime during three years (1948 to 1950).

The percentage of flowering plants average 29 % in the manured plots.

It should also be noted that treatments j and k showed no pathological symptoms.

The new aims ascribed to the Gimbi Station in the field of sisal cropping are the determination of the most economic nutrient formula, the preparation of the most suitable techniques for the mechanization of the culture and the application of modern procedures for the fibre extraction.

URENA LOBATA

A remarkable increase in yield (20 - 25 %) and in technological properties of fibres was obtained by pedigree selection. The percentage of fibres in green leafless material has risen from 4,5 to 6,5 % for the best lines.

Treatment	1950		1951		1952		1953		1950 to 1953.	
	Leaves	Fibres	Leaves	Fibres	Leaves	Fibres	Leaves	Fibres	Leaves	Fibres
a) Degraded savanna (control)	6.960	208	8.151	207	15.924	181	6.380	198	27.415	794
b) Spontaneously reforested savanna after 8 years protection against fires; no tillage	10.170	209	9.781	226	10.568	306	11.693	305	42.212	1.046
c) As <u>b</u> but with tillage	15.990	455	15.229	435	15.097	439	18.561	603	64.877	1.932
d) Mulch	19.450	455	26.304	967	15.741	504	29.310	1.324	90.805	3.250
e) Lime (2 t)	33.095	1.035	42.939	1.596	29.003	1.015	31.780	1.026	136.817	4.672
f) Compost in ditches	24.660	848	42.135	1.397	37.808	1.277	56.309	2.410	160.912	5.932
g) lime (4 t)	31.140	918	36.869	1.222	43.415	1.519	67.470	2.658	178.884	6.317
h) lime (2 t) + compost (10 t)	29.110	946	58.117	2.230	59.247	2.073	82.450	83.355	227.924	8.604
i) Forest soil (3rd place in the rotation)	43.280	1.384	41.088	1.327	47.878	1.062	110.527	4.630	242.773	8.403
j) Lime (2 t) + mineral fertilizer	42.850	1.216	59.414	2.227	66.993	2.697	102.970	4.880	272.227	11.020
k) Lime (4 t) + mineral fertilizer	40.884	1.214	58.614	2.141	44.995	1.408	128.070	6.070	272.563	10.833

Urena, being an exacting plant, produces the highest yields as the first crop of the rotation in fertile and fresh forest soils.

The experiments carried out since 1951 indicate that cropping would be possible in savanna with fertilizer dressings.

The following table summarizes the results of field trials on plots simultaneously cleared in savanna and in forest and submitted to the same field operations. It shows that interesting yields were obtained in the 2nd year in savanna, as well for fibre as for seed production (yields in kg products per ha) :

	Urena in 1st culture (1951-1952).		Urena in 2nd culture (1952-53).			
	Leafless stems		Leafless stems		Seeds	
	Savanna	Forest	Savanna	Forest	Savanna	Forest
Control	2.523	18.379	4.800 (5,8)	13.935 (5,96)	505	473
2,5 t lime	5.822	15.850	11.160 (6,69)	9.383 (5,96)	1.265	568
5 t lime	7.242	15.041	9.080 (6,59)	6.062 (5,92)	1.240	433
2,5 t lime + 100 NPK units (10-10-10)	17.289	23.201	22.560 (7,69)	16.882 (6,46)	905	673
2,5 t lime + 66 NPK units (10-10-10)	14.607	21.633	18.240 (7,80)	19.492 (6,28)	1.160	583
2,5 t lime + 33 NPK units (10-10-10)	13.645	20.238	13.840 (6,84)	17.347 (6,56)	900	433
Formula 3" (750 kg)	12.136	19.321	14.160 (7,06)	14.188 (6,37)	652	523

The numbers in parentheses give the percentages of fibres obtained by retting of leafless stems.

The equilibrated "formula 3" contains on a total of 100 kg, 39 kg ammonium nitrate, 20 kg bicalcium phosphate, 30 kg potassium sulphate, 2 kg lime and 9 kg magnesia.

Besides the quantitative and technological amelioration of Urena, the Station tries to establish the ecological requirements of the crop in various conditions.

The possibilities for mechanization of cropping, harvesting, and retting are also considered.

VARIOUS FIBRE CROPS.

Among the other economical species which present some interest in the local conditions we list : Sida rhombifolia, Triumfetta cordifolia, T. rhomboidea, Hibiscus esculentus, Abutilon angularis and Corchorus olitorius.

FOOD CROPS.

Gimbi es a station of 2nd order in the network of stations for breeding and experimentation of food crops.

Among the more closely studied plants we mention cassava, banana, maize, groundnuts, and sweet potatoes.

These crops are also observed in rotation with Urena.

VARIOUS ECONOMIC CROPS.

Rubber and cacao tree and Aleurites montana are also studied.

VARIOUS ACTIVITIES.

Experiments on forest regeneration (by protection of savannas against fires), enrichment and reforestation (Okoume, Tectona grandis, Albizzia lebbeck and Cassia siamea) are organized in collaboration with the Forestry Centre of Luki.

Rearing of cattle (Dahomey and Ndama races) and investigations on pisciculture are also worth mentioning.

Plants and seeds distributed by the Station since 1947.

Seed : <u>Urena lobata</u>	7.153 kg.
Various fibre crops	413 kg.
Food crops	83 kg.
Forest species	50 kg.
Leguminous cover crops	2.350 kg.
Fodder crops	23 kg.
Hevea	57.500 kg.
Sisal bulbils	79.500 .
Banana bulbs	35.127 .
Clonal hevea plants	14.900 .
Various plants and tubercles	1.372 .

GEOLOGIE DE LA REGION DE YANGAMBI.

La région de Yangambi présente un relief peu accusé. Les formes molles de la topographie s'élèvent à peine de plus de 100 m. au-dessus du cours du fleuve, situé à environ 400 m. d'altitude.

Partout on ne voit que des sols sableux de teintes variées; les affleurements rocheux et les falaises sont exceptionnels. L'impression d'uniformité est encore accusée par le couvert de la grande forêt équatoriale.

Trois groupes principaux d'éléments composent le visage de ce pays :

- a) Le cours du fleuve avec ses terrasses et, plus au nord, le cours de l'Aruwimi.
- b) Les hauts plateaux à couverture sableuse.
- c) Les pointements rocheux et autres affleurements de substratum. Le chevelu hydrographique, encastré dans des vallées à profil concave, se dispose en fonction de ces éléments.

Le fleuve et ses terrasses :

Le cours du fleuve s'étend entre des îles de nature alluviale, diversement évoluées, mais toutes géologiquement récentes.

Les graviers de fond de vallée, émoussés, patinés, contiennent de rares échantillons remaniés d'industries lithiques.

Les basses terrasses dont les surfaces s'établissent à environ 5 m. au-dessus des eaux, sont constituées de sables argileux gleyifiés, reposant sur des bancs épars de cailloutis, incrustés de limonite.

Les terrasses dont les surfaces s'établissent à environ 15-20 m. au-dessus des eaux, sont constituées de sables jaunes ou blancs lavés, reposant sur des cailloutis silicieux à patine luisante; ceux-ci contiennent, à l'état remanié, des éclats tayacoides. L'épaisseur des sables atteint quelques mètres.

Les terrasses dont les surfaces s'établissent à environ 30 m. au-dessus des eaux sont constituées de sables ocre jaune reposant sur des cailloutis quartzeux, à patine mate. Ceux-ci se situent à une vingtaine de mètres au-dessus des eaux.

Les hauts plateaux sableux :

Ceux-ci ont une topographie subhorizontale et imperceptiblement ondulée, se raccordent aux terrasses par des pentes un peu plus accentuées. Ils sont constitués d'une puissante couverture de sables limoneux jaune rouge, certainement épaisse de plusieurs dizaines de mètres. La composition granulométrique, l'homogénéité verticale et horizontale, l'absence de toute stratification, la répartition de cette formation font admettre à cette dernière une origine éolienne. En un point (source de la Lubilia) on a recueilli à sa base des cailloux éolisés. Toutefois l'analyse microscopique des sables ne donne pas un résultat très net, la majorité des grains étant un peu usés.

Les sables des plateaux reposent sur une surface d'érosion où les restes plus ou moins démantelés d'une nappe de concrétions limonitiques. Celles-ci atteignent une puissance de 5 à 10 m. lorsqu'elle est bien conservée; son origine est à la fois alluviale et éolienne. En effet, on y voit des accumulations graveleuses stratifiées, des conglomérats de nodules, des croûtes intraformationnelles et des précipitations insitu.

Cette nappe de concrétions a une répartition très vaste, le long du fleuve, elle se situe à une quarantaine de mètres au-dessus des eaux et on la voit grimper sur les rares pointements rocheux surbaissés de la crête qui sépare le Congo de l'Aruwimi. Elle s'est formée lors d'un stade extrême de pénéplanation, en topographie semi-noyée, probablement au climat oscillant.

La série de Yangambi :

Cette formation sédimentaire dont l'existence a déjà été soupçonnée en 1923 par J. HENRY, n'a été individualisée que tout récemment. Elle n'apparaît bien que dans les grandes falaises du fleuve, en amont de Yangambi (rive droite) et près d'Elisabetha (rive gauche).

C'est une formation sableuse nettement stratifiée, légèrement indurée, contenant des bancs violacés, argileux marqués de profondes fentes de dessiccation. A la base (Elisabetha) elle repose sur un poudingue quartzeux plus ou moins cimenté d'oxyde de fer et associé à de la bauxite; à Yangambi la base se trouve sous le niveau des eaux, mais on rencontre quelques lits graveleux au pied des falaises.

Au sommet, la formation semble passer sans hiatus marqué à la nappe de concrétions limonitiques. Peut-être un horizon à galets éoliens se localise-t-il là. L'abondance des grains ronds mats travaillés par le vent, qui atteignent 75 % dans certains horizons, et l'intensité des fentes de dessiccation sont tout à fait remarquables. Toutefois les galets enchâssés au pied des falaises ne sont pas éolisés. La série sédimentaire de Yangambi a été déposée en bassin fermé sous régime désertique. On peut se figurer un épandage sableux brassé par le vent et des "plays" en voie de dessiccation. Bancs argileux rouges et bauxites proviennent du remaniement d'anciennes formations latéritiques riveraines.

Le Karroo:

Le Karroo triasique, peut-être même jurassique, est bien visible dans la région de Stanleyville; les couches plongent vers l'ouest et à hauteur de Yangambi, disparaissent sous des formations plus jeunes. Ce sont des grès tendres, des argilites, des grès calcareux, des schistes rouges ou verts, des couches bitumeuses. L'étage de Stanleyville contient une belle faune d'entomoses tracés et de poissons.

Le substratum rocheux :

Le substratum rocheux apparaît en quelques pointements dispersés et au fond de certaines vallées.

Les grandes vallées de l'Aruwimi, de la Lindi et de la Tshopo laissent affleurer les grès rouges et les calcaires du groupe de la Lindi d'âge paléozoïque ancien ou précambrien. Ces roches dures déterminent des séries impressionnantes de chutes et de rapides (rapides de Yambuya, chute de la Tshopo, rapides de la Lindi, pêcheries des Wagenias).

Le groupe de la Lindi contient une formation glaciaire, tillite à blocs. Les formations sédimentaires du socle ancien centre-africain présentent le caractère de ne devant d'être complètement dépourvus de fossiles et sont donc malaisément datables.

Raccords stratigraphiques et âge des formations :

Les seuls arguments dont on dispose pour dater les formations post-Karroo de la région de Yangambi sont :

- 1° l'extension de la nappe des concrétions limonitiques et sa position géomorphologique.
- 2° les raccords avec des formations voisines.
- 3° les rares spécimens d'industrie lithique.

La nappe des concrétions limonitiques qui se situe sous les plateaux de Yangambi se poursuit vers l'est, au-delà de la région du fleuve et semble venir s'étaler sur l'une des surfaces d'aplanissement principales du centre africain. Cette "pénéplaine" est couramment attribuée à la Fin-Pléistocène. Les concrétions limonitiques marqueraient donc, en gros, la limite Plio-Pléistocène. Point n'est besoin de souligner ce qu'il y a de largement approximatif dans cette estimation.

Les terrasses fluviales ne permettent aucun raccord avec d'autres bassins, les facteurs régionaux (déformations par épirogénèse, nature du substratum etc..) ayant une influence prépondérante.

Les sables de recouvrement des hauts plateaux peuvent être mis en parallèle avec la série de la Salonga dans la Tshuapa, rapportées au Pléistocène inférieur.

La série sédimentaire de Yangambi peut-être parallélisée avec la série de la Lodpa et le poudingue d'Opsla. Elle est sûrement d'âge tertiaire supérieur, vraisemblablement pliocène.

.../...

On remarquera sans doute que le système du Kalahari n'a pas été mentionné. C'est, en effet, qu'on ignore encore quelles sont les équivalences stratigraphiques des formations de la cuvette du Congo avec celles du Kasai-Kwango, de Rhodésie et d'Afrique Australe, où le système du Kalahari est caractérisé.

Ce nom a d'ailleurs été étendu abusivement à tous les recouvrements de sables limoneux, sans tenir compte de leur âge et de leurs positions morphologiques diverses. Il est souhaitable de restreindre l'usage du terme de Kalahari aux formations silicifiées et aux sables éoliens épais de la pénéplaine mi-tertiaire tels qu'on peut les définir dans le sud du bassin du Congo.

Variations climatiques, paléosols :

Les formations post-Karoo de la région de Yangambi mettent en lumière des fluctuations climatiques importantes qui se sont déroulées entre le Néogène et la période actuelle. Résumons rapidement, dans l'ordre de succession :

- Altérations latéritiques (bauxites etc.) pré-série de Yangambi. = climat chaud et humide.
- Série de Yangambi (Pliocène ?) : climat nettement désertique.
- Nappes de concrétions limonitiques : climat oscillant, topographie semi-noyée, insola-tions, transports chimiques.
- Recouvrement des hauts plateaux sableux (Pléistocène inférieur ?) : apports éoliens, désert ou steppe saharienne.
- Replat de terrasse de 25-30 m. (Pléistocène moyen ?) : démantèlements par les eaux flu-viales, climat humide.
- Intervalle terrasses 30 m. et 15 m. : peut-être épisode d'aridité (sculpture de galets ?)
- Terrasses de 15 m. et plus bas, sables blancs, basse terrasse : climat voisin de l'ac-tuel.

Il va sans dire que bien d'autres fluctuations climatiques non encore détec-tées ont pu avoir lieu entre celles-là.

Les diverses périodes ont laissé leurs empreintes, non seulement sous for-me de paléosols. De nombreux paléosols sont intercalés dans la série de Yangambi; la nap-pe de concrétions limonitiques est un paléosol complexe, la surface des hauts plateaux sableux a connu une longue évolution pendant laquelle les sols ont pénétré en profondeur. Même sur certaines surfaces jeunes, comme les sables de Lilanda, des sols se sont instal-lés qui paraissent en partie fossiles.

Pour interpréter correctement un profil pédologique moderne sous les condi-tions climatiques modernes, il faut faire intervenir :

- 1° le matériel de départ qui est souvent un sol ancien plus ou moins complexe, ayant évo-lué longtemps sous des conditions climatiques différentes et non pas la "roche mère" vierge.
- 2° la durée d'évolution, selon que la surface morphologique est plus ou moins jeune ou plus ou moins décapée.

Guide to the first field trip (alluvial soils)

From the beach the road follows for a short distance the natural levee of the river crossing the Isalowe and Losambila at their confluent.

A rather steep incline on the slope of the Losambila valley leads to the upland on which the road follows the north bank of the river for a few miles.

Then a smooth slope takes us to a point where appears the ironstone layer underlying the sandy sediment. The ironstone is quarried for road metal since the natural configuration of the land permits its exploitation here which is rarely feasible elsewhere.

After the Yakonde village there is a steep descent toward the sandy flat of the Boonde. Between this stream and Lilanda, terminal point of this field trip, the road never rises again to the level of the upland.

At Lilanda, we will examine a ground water podzol in the white sand plain characteristic of this locality.

Going back to Yangambi, after crossing again the Boonde we turn right toward an expanse of alluvial soils which is presently developed with heavy agricultural machinery for the establishment of permanent pastures and the mechanized production of food crops. A typical alluvial profile is examined here.

CHAPITRE I. Les Unités Paysagiques.

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Les unités formées par les dépôts du fleuve Congo ont toutes une direction N-W, grossièrement parallèle au cours actuel; quant aux alluvions de la Lilanda et de la Boonde elles se sont imbriquées dans les autres unités de la plaine.

§ 1. Unités Riveraines et îles anciennes.

Depuis Yangambi jusque Bokao, le rivage proprement dit est formé d'alluvions lourdes formant des dénivellations bien visibles sur le niveau général de la plaine.

Cette unité rivéraine, réduite à ce cas simple, s'observe entre la Boonde et la Lilanda. Des formations plus complexes s'observent par contre à la Presqu'île des LOKELE; elles nous offrent un exemple de la genèse des îles: dépôt d'un banc de sable sur le lit du fleuve - colonisation par la végétation - fixation d'alluvions plus lourdes (fixation moins effective au centre) - et formation d'une dépression intérieure.

Dans ce dernier cas, on observe le colmatage d'anciens chenaux avec, comme conséquence, l'intégration de cette île dans la plaine alluviale.

Toute la plaine alluviale est découpée par des dépressions allongées dans le sens du courant; la partie amont de ces dépressions est exondée d'une manière permanente tandis que la partie aval, périodiquement inondée, reste en connexion avec le fleuve.

En bordure de ces dépressions, on observe des sédiments lourds de texture argilo-limoneuse, auxquels font suite des dépôts alluvionnaires plus légers. Ces différentes unités sont notées M et F sur la carte des sols. La morphologie des unités M est pratiquement fixée et en dehors des dépressions, ces sols ne sont que très rarement inondés. L'unité F est constituée de matériel récemment déposé et se forme même encore actuellement en aval de Yaekela lors des crues du fleuve.

§ 2. Formations développées entre les unités riveraines et les colluvions des plateaux.

Diverses observations nous autorisent à admettre l'existence d'alluvions plus anciennes. Cette unité paysagique apparaît à un niveau légèrement supérieur aux formations riveraines.

- 1) - le village de Yayoli, installé sur une bande de cette unité, domine l'unité de la rive et la plaine de Lilanda.
- 2) - le long du chenal de la Station de Yaekama, un relevé altimétrique montre une différence d'environ 2 mètres, alors qu'il passe sur un point bas des alluvions anciennes.

La nature différente des dépôts eux-même semble confirmer cette hypothèse.

- De Yangambi à la Boonde le passage vers les colluvions de plateaux est caractérisé par un sédiment sablo-argileux (unité R) dans lequel on retrouve des lits discontinus de cailloux roulés. Cette formation correspondrait probablement à une ancienne rive ou à un ancien niveau d'alluvions (fausses terrasses).
- Entre la Boonde et la Lilanda, la plaine alluviale s'élargit sur environ 4 à 5 km. en profondeur. La limite N est caractérisée par une bande marécageuse large de 1 à 2 km, dans laquelle, sous une couche tourbeuse atteignant parfois 1 m, on retrouve un sable gris blanc. Au delà de ce marécage vers le fleuve, apparaît une succession d'îlots formés d'alluvions anciennes argilo-sableuses à sablo-argileuses (notés K). Cette formation repose sur un sédiment plus lourd. La transition est matérialisée par un niveau graveleux relevé à des profondeurs variables dans le profil, l'amplitude de variation pouvant atteindre 2 m. Cette topographie est fixée dans les conditions actuelles; à la saison des pluies, les petits ruisseaux et l'eau ruisselant les versants élèvent le niveau de la nappe aquifère. Entre les îlots, il n'est pas rare d'observer un courant d'eau limpide teinté de matières organiques.

§ 3. Plaine alluviale de la Lilanda et des tributaires.

A ces unités se rattachent les alluvions des différents tributaires du fleuve. Ces dépôts alluvionnaires (notés S) sont issus des sables de plateaux et se sont accumulés en une petite plaine dont l'importance est fonction du réseau hydrographique de la rivière.

La plus importante et la plus typique de ces plaines est celle de la Lilanda qui couvre une superficie de 200 à 300 ha. La rivière Lilanda débouche dans le complexe alluvial au pied du village de Yambeli.

Il apparaît probable que les alluvions sablonneuses de la Lilanda aient comblé la dépression marécageuse qui prolonge celle décrite entre la Boonde et la Lilanda et qui se retrouve plus au Nord. Le cours de la Lilanda traverse ensuite l'unité d'alluvions anciennes (§ 2) et son confluent avec le fleuve forme une vaste expansion marécageuse.

Il est à noter que la rive gauche de la Lilanda est presque toujours sous eau tandis que tout au long de la rive droite s'étendent les champs indigènes. De mémoire d'homme (de 50 à 75 ans) toute cette région était également marécageuse; actuellement, ces marécages se réduisent à quelques dépressions locales.

La plaine de la Boonde couvre une surface moins importante tandis que les autres petits affluents n'ont alluvionné que leurs abords immédiats.

§ 4. Au Nord de la Lilanda.

En direction N-W. la largeur de la plaine alluviale diminue progressivement pour se réduire à 300-400 m près du village de Bokao. Immédiatement en aval de la Lilanda on retrouve l'unité d'alluvions anciennes et la dépression marécageuse.

En aval du village de Yaekela, l'unité rivéraine (M) réapparaît. De nombreuses dépressions découpent la plaine alluviale et confluent en un immense marécage d'où émerge l'un ou l'autre banc de sable.

Plus au Nord, la rive est réduite à une mince digue de formation récente (F) qui se prolonge jusque Bokao.

Sur la route de Bokao un replat d'alluvions sablonneuses des petits ruisseaux (petite plaine de piedmont) domine la plaine marécageuse par une rupture de pente très nette.

CHAPITRE II. Les formations alluvionnaires. =====

L'examen des dépôts alluvionnaires permet donc de les scinder en 3 catégories :

§ 1. Les dépôts alluvionnaires du fleuve.

Le profil s'est développé dans un sédiment qui repose sur un banc de sable ocre jaune très micacé, lequel recouvre un niveau graveleux. La texture, l'épaisseur et l'homogénéité de ces dépôts sont liées à l'unité paysagique qu'ils forment.

a) les rives alluviales sont constituées d'alluvions lourdes, homogènes sur 2 à 3 mètres de profondeur. Ces dépôts superficiels contiennent une fraction limoneuse (2 à 20 microns) importante (jusqu'à 25 %) qui serait à mettre en relation avec la présence de micas blancs. Leur couleur varie faiblement dans la gamme de 7.5 YR.

b) Dans la plaine alluviale, des dépôts argilo-limono-sableux à sablo-argilo-limoneux atteignent une profondeur de 150 cm; ils sont caractérisés par un pourcentage moins élevé en limon.

c) Dans les dépressions, la texture est variable et le profil contient souvent des matériaux grossiers.

§ 2. Les alluvions anciennes.

a) En transition vers les colluvions de plateau, les dépôts sont sablonno-argileux et on y observe des lits discontinus de cailloux roulés. Ces dépôts se retrouvent en R sur la carte des sols.

b) Les îlots, précédemment décrits, sont formés d'alluvions qui reposent en général sans transition sur un niveau graveleux recouvrant des alluvions plus lourdes. Ces dépôts d'épaisseur variable de 1 à 5 m et de texture argilo-sableuse (K₃) à sablo-argileuse (K₂) sont caractérisés par un faible pourcentage de limon et de micas (5 %) - la fraction des sables montre un maximum pour les éléments de 50 à 200 microns. Leur couleur est toujours dans la gamme des 10 YR.

§ 3. Les dépôts alluvionnaires des affluents.

Ces dépôts portent l'empreinte nette de leur origine (plateau de sédiment éolien) ils sont légers, sans limon et leur couleur est grisâtre (dans les 10 YR).

La texture de ces alluvions varie régulièrement devenant moins grossière lorsqu'on s'écarte des rivières. La granulométrie de ces dépôts montre un léger maximum pour la fraction entre 20 et 50 microns et un autre plus marqué dans la fraction 250 - 500 microns. Ces alluvions reposent sur des dépôts lourds du fleuve, sédiments hydromorphes, par l'intermédiaire d'un lit de gravier ou de cailloux.

CHAPITRE III. Les Sols.

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§ 1. Bases de Classification.

Les principaux critères de différenciation des séries pris en considération sont les suivants :

- A) l'origine ainsi que l'âge relatif des matériaux alluvionnaires -
- B) la texture du sédiment -
- C) Les conditions de drainage interne :

- 1 - sols bien drainés -
- 2 - sols imparfaitement drainés avec mottling et gley apparaissant entre 80 et 100 cm: indice a.
- 3 - sols mal drainés; la rouille remonte près de la surface et le gley est bien marqué à 50 cm : indice b
- 4 - sols des marais intermittents : indice c
- 5 - sols des marais permanents : indice d.

Ces différentes classes de drainage se caractérisent comme suit :

a- et b- L'apparition du gley modifie l'allure normale du profil par ses figures caractéristiques, par une destruction de la structure et par une diminution de la porosité avec leurs conséquences sur l'enracinement des plantes.

En profondeur, la gleyification peut se présenter sous forme de petites concrétions ferrugineuses (petits granules plus ou moins friables).

c - Les marais intermittents : les sols de ces unités sont réduits jusqu'en surface, l'horizon humifère est grisâtre et très rouillé. La nature du dépôt alluvionnaire est souvent très masquée par cette évolution; le fait d'être marais intermittent est d'ailleurs la caractéristique pédologique prédominante de ces unités. On rencontrera sur la carte l'indice c employé seul sans indication au sujet du dépôt.

d - Les marais permanents constamment sous eau. Dans ces marais c et d on observe fréquemment une couche humifère à tendance tourbeuse de 100 à 200 cm d'épaisseur; ils sont indiqués par T sur la carte des sols.

Etablir une limite exacte entre marais permanents et intermittents n'est pratiquement pas possible.

§ II. Caractérisation pédologique et analytique des principales unités cartographiées.

A. Sols développés dans les dépôts alluvionnaire du fleuve.

1. Série Fa

Sols des formations récentes. Hormis un début d'infiltration humifère aucune différenciation n'apparaît dans le profil. On y note la succession de dépôts argilo-limoneux riches en paillettes de mica. L'ensemble est de couleur gris foncé due à la présence d'une matière organique très décomposée. Ces sols se caractérisent par une très grande porosité; leur profondeur dépasse rarement 100 cm.

Description du Profil :

- 0 - 12 : sous une litière mince et peu décomposée, horizon enrichi en humus - 10 YR 3/4.
argilo-limoneux - structure grumeleuse - frais - friable.
- 12 - 22 : matériel léger sans infiltration humifère - 10 YR 3/4
argilo-limoneux - structure grumeleuse.
- 22 - 65 : dépôt plus lourd - 10 YR 4/4 - 4/3
- argilo-limoneux - structure grumeleuse à subanguleuse très bien développée, infiltration humifère le long des racines très friable - très poreux - frais - racines et radicelles.
- 65 - 92 : dépôt plus léger - horizon à taches de rouille 10 YR 5/3
argilo-limoneux - structure moins bonne, plus tassée - consistance plus ferme, encore des racines.
- 92 et + horizon D - dépôt lourd - argilo-limoneux, tassé
horizon gley intense, totalement réduit.

2. Série M₄a

Sol typique des rives alluviales.
Le profil est différencié et est de texture argilo-limoneuse, riche en paillettes de mica. Il est caractérisé par une structure très bien développée, subanguleuse, polyédrique et par la présence d'un horizon B textural et structural. Les horizons B présentent sur les faces des agrégats anguleux des patines argileuses (coatings).

Description du profil.

Profil argilo-limoneux, à gley en profondeur; nappe phréatique à 1 m,60. (saison des pluies).

Végétation : forêt lianeuse.

Litière : litière très mince de feuilles bien décomposées.

- 0 - 3 : horizon humifère peu épais - 7.5 YR 4/2.
argilo-limoneux, structure grumeleuse - meuble - fouillis très dense de racines et radicelles - frais.
- 3 - 10 : horizon d'infiltration peu marqué et ondulé 7.5 YR 4/4
argilo-limoneux - structure grumeleuse - meuble - très nombreuses racines et radicelles - frais.

- 10 - 20 : horizon de transition 7.5 YR 5/5, argilo-limoneux - structure subanguleuse - friable - quelques trainées humifères - quelques racines - frais.
- 20 - 80 : horizon B₂- 7.5 YR 5/6 argilo-limoneux - structure subanguleuse à anguleuse, bien marquée (à tendance polyédrique) patines argileuse (coatings) friable - quelques racines - frais - quelques marbrures.
- 80 - 150 : horizon B-C 7.5 5/7 argilo-limoneux - structure subanguleuse - légèrement tassé - quelques rares racines - humide - plages de rouille bien prononcées.
- 150 - 250 : horizon CG 7.5 YR 5/8, argilo-limoneux - structure subanguleuse - tassé - gley bien marqué - mouilleux - nappe phréatique à 1,60 m.
- 250 - 300 : horizon DG - gleyification intense - tassé - mouilleux - dépôt argilo-limono-sableux, horizon de concrétionnement: concrétions de fer sous forme de petits granules friables - trainées noirâtres (concrétions de Mn).
- H8 300 : horizon D₂
dépôt sablo-argilo-limoneux: sable enrobé d'argile - gleyifié - mouilleux.

Ce profil est caractérisé par une capacité totale d'échange élevée de l'ordre de 20 à 25 m.e./100g. mais le degré de saturation est très faible, de 10 à 15 %.

3. Série M₃

Ces sols sont associés géographiquement aux M₄ mais ils sont souvent moins profonds. Le profil est différencié et de texture argilo-limono-sableuse, riche en micas (fraction limoneuse moins importante). Il est caractérisé par une structure^{ab} anguleuse bien développée et par la présence d'un horizon B textural et structural (coatings).

Description du profil.

- 0 - 10 : horizon humifère bien net 7.5 YR 4/4, argilo-limono-sableux structure grumelleuse - meuble - fouillis de racines et radicelles - frais.
- 10 - 27 : horizon d'infiltration bien marqué, ondulé 7.5 YR 5/4, argilo-limono-sableux - structure subanguleuse - friable - fouillis de racines et radicelles - quelques traces de charbon de bois - frais.
- 27 - 33 : horizon de transition 7.5 YR 5/6 argilo-limono-sableux - structure subanguleuse - friable - nombreuses racines - quelques trainées brunâtres le long des racines - frais - quelques galeries de termites.
- 35 - 75 : horizon B₂ 7.5 YR 6/6, argilo-limono-sableux - structure subanguleuse à anguleuse - quelques patines argileuses sur les faces de structure - friable - encore des racines - frais.
- 75 - 90 : horizon C 7.5 YR 6/8 plus sableux - tassé - perd sa structure - encore des racines - humide.

90 - 120 : horizon Cg 7.5 YR 5/8, argilo-limono-sableux - peu structuré - friable - encore quelques racines - très humide - quelques plages de rouille.

120 et + horizon D 10 YR 6/6, sable ~~ocre~~ jaune enrobé d'argile - bouillant - gleyifié, mouilleux - larges plages de rouille.

Ce profil est caractérisé par une capacité totale d'échange de l'ordre de 12 à 15 m.e./100g, le degré de saturation étant de 20 à 25 %.

4. Série M₂

Ces sols se sont déposés au centre de la plaine alluviale. Le profil est peu différencié, hormis des horizons humifères épais. La texture varie de sablo-argileuse à sablonno-argileuse. Le pourcentage de limon est faible (8 %); le profil contient du mica. La structure est ^{sub}anguleuse, peu développée. Ces sols sont en général peu profonds (100 à 150 cm).

Description du profil.

- 0 - 4 : horizon humifère 7.5 YR 4/4, sablonno-argilo-limoneux peu structuré - meuble - micas blanc - nombreuses radicelles - frais.
- 4 - 30 : horizon d'infiltration bien marqué 7.5 YR 5/4 sablonno-argilo-limoneux - structure grumaleuse peu développée - meuble - micas blancs - nombreuses racines - frais.
- 30 - 90 : horizon B-C 7.5 YR 5/6, sablonno-argilo-limoneux structure subanguleuse peu développée - gros micas - nombreuses radicelles - frais - nombreuses galeries.
- 90 - 115 : horizon C 7.5 YR 5/8 sablonno-argilo-limoneux, très peu structuré - gros micas - radicelles - frais - nombreuses galeries.
- 115 - 165 : horizon D₁ 7.5 YR 6/6 sablonneux - sable jaune enrobé d'argile - bourré de micas - sans structure - pas de racines - frais.
- 165 - 190 : horizon D₂ sable ocre jaune très micacé 7.5 YR 6/8 bouillant.
- 190 et + horizon D₃ : graveleux - nappe phréatique.

Ce profil est caractérisé par une capacité totale d'échange de l'ordre de 5 à 6 m.e./100g et son degré de saturation varie de 20 à 25 %.

5. Série M₁

Cette série est associée à la série M₂.

Le profil est peu différencié et les horizons humifères sont épais. Le sédiment est de texture sablonno-argileuse mais le pourcentage de limon est très faible de l'ordre de 4 à 5 %. L'infiltration humifère est importante et la structure est très peu développée.

Description du profil.

- 0 - 10 : horizon humifère important - 10 YR 4/4, sablonno-argileux sans structure - meuble - micas - fouillis dense de racines et radicelles - sec.
- 10 - 25 : horizon d'infiltration bien marqué 10 YR 5/6 sablonno-argileux - sans structure - meuble - micas nombreux - nombreuses racines et radicelles - nombreuses galeries - frais.
- 25 - 45 : horizon de transition avec quelques trainées brunâtres 7.5 YR 5/6, sablonno-argileux - friable - nombreuses racines - frais - micas nombreux.
- 45 - 80 : horizon B.C - 7.5 YR 5/8, sablonno-argileux - nombreux micas, structure subanguleuse très peu développée - friable - racines encore nombreuses - frais.
- 80 - 110 : horizon C. - 7.5 YR 6/8, sablonno-argileux, sans structure - friable - encore des racines - frais.
- 110 - 160 : horizon D₁ : sablonneux 10 YR 6/10, sable ocre-jaune bourré de micas - sable bouillant.
- 160 et + : horizon D₂ : horizon graveleux; à 190 nappe phréatique.

Ce profil est caractérisé par une faible capacité d'échange (3 à 5 m.e./100 g), son degré de saturation est de l'ordre de 20 %.

6. Série Mo

Ces formations se localisent dans les dépressions marécageuses. Le sédiment est un sable grossier ou un dépôt graveleux. En surface, le sable coloré en noir par l'humus est enrobé d'argile (5 à 7 % argile); les micas sont nombreux. Les couches graveleuses donnent un refus important (33 %) au tamis de 2 mm. Ces profils sont gleyifiés sur toute leur profondeur.

B. Sols des alluvions anciennes.

Parmi les critères nous permettant de les distinguer des alluvions plus récentes, le caractère textural est déterminant. A ce point de vue, nous notons un pourcentage plus faible de limon (3 à 5 %) avec un maximum nettement défini, réparti dans les fractions sableuses 50 à 250 microns, leur couleur est plus grise (dans la gamme des 10 YR) et leur consistance moins ferme. Deux séries y ont été définies : K₂ à texture sablo-argileuse, et K₃ à texture argilo-sableuse.

Description d'un profil K₃.

Litière peu épaisse de feuilles et radicelles décomposées.

- 0 - 6 : horizon humifère - 10 YR 3/2 - 3/3, argilo-sableuse - structure grumeleuse bien développée chevelu de racines et radicelles, friable - frais - limite régulière.
- 6 - 18 : horizon d'infiltration humifère 10 YR 5/3 - 3/4 argilo-sableux - structure subanguleuse moyenne, peu développée, beaucoup de racines et radicelles - très poreux - friable - limite diffuse.

- 18 - 29 : horizon de transition - 10 YR 5/4
argilo-sableux - structure subanguleuse moyenne, nombreuses
radicelles - meuble - limite peu nette.
- 29 - 72 : horizon B₂ - 10 YR 6/4 - 6/6
argilo-sableux - structure subanguleuse - patines argileuses
sur les agregats structuraux - nombreuses radicelles -
très poreux - meuble - humide - limite irrégulière.
- 72 - 100 : horizon BC 10 YR 6/6 - 6/4
argilo-sableux - structure subanguleuse - quelques patines
argileuses, quelques racines - ferme - humide.
- 100 - 150 : horizon Cg 10 YR 6/6.
argilo-sableux - quelques taches de rouille, structure
anguleuse se détruit - ferme - humide - limite nette.
- 150 - 225 : horizon Cg
gley plus intense.
- 225 et + bas: horizon D graveleux (cailloux brisés et sable grossier)
Tout le profil contient du mica.

C. Séries alluvionnaires de la Lilanda et des tributaires.

Série So.

Sol peu épais, (50 à 60 cm) à sable blanc grossier typique sans trace
d'argile. Ce sable grossier se retrouve dans le lit des rivières.
Très souvent, recouvert d'un horizon organique à tendance tourbeuse
cette série correspond à une bande marécageuse aux abords de la rivière.

Série S₁

Sol assez profond (150 cm) de texture sablonneuse. Les horizons
humifères sont épais, profonds, sablonneux et sans structure.
Les horizons de profondeur présentent une structure subanguleuse très
peu développée.

Description du profil.

Profil S₁

Sol moyennement profond, peu différencié hormis des horizons humifères
épais. Alluvions sablonneuses de la Lilanda.

- 0 - 11 : horizon humifère 10 YR 3/2
sablonneux avec grains de sable blanc délavés - sans
structure, nombreuses racines et radicelles - sec - friable
- limite diffuse.
- 11 - 21 : horizon d'infiltration humifère 10 YR 4/2
sablonneux - sans structure, racines et radicelles
nombreuses - quelques charbons de bois - friable - sec -
limite irrégulière.
- 21 - 37 : horizon d'infiltration 10 YR 4/2
sablonneux - structure subanguleuse très peu développée -
racines et radicelles nombreuses - friable - sec - limite
ondulée.
- 37 - 57 : horizon BC (?) 10 YR 4/4, sablonneux - structure subangu-
leuse peu développée - nombreuses racines et radicelles -
friable - sec.
- 57 - 150 : horizon C 10 YR 6/4
sablonneux - sans structure - friable - sec.

Série S₂

Sol profond (200 cm et plus) de texture sablonno-argileuse. Les horizons humifères sont épais. En profondeur, on note une structure subanguleuse assez bien développée.

Série S_p

Sol sablonneux à sablonno-argileux, profond, nettement différencié montrant un horizon humifère épais et bien marqué, un horizon brunâtre nettement tranché par sa couleur; sur ce fond brunâtre se détachent quelques petites plages arrondies de couleur noirâtre, légèrement indurées (accumulation humifère ?)

- 0 - 12 : horizon humifère (remanié par la culture) 10 YR 3/2
sablonneux - structure sablonneuse avec quelques grumeaux
adhérant aux racines, fouillis dense de radicelles,
meuble - sec - limite régulière.
- 12 - 27 : horizon d'infiltration (1) 10 YR 4/2, sablonneux -
structure à tendance grumelleuse (grains légèrement
cimentés les uns aux autres) - radicelles nombreuses,
quelques traces de charbons de bois, meuble et sec -
limite moins nette.
- 27 - 43 : horizon d'infiltration (2) 10 YR 4/2
sablonneux - structure subanguleuse très peu développée
beaucoup de racines et radicelles - quelques traces de
charbons de bois, trainées humifères bien marquées.
- 43 - 53 : horizon de transition 7.5 YR 4/2, sablonneux - struc-
ture subanguleuse peu stable - radicelles nombreuses,
frais - meuble - limite ondulée.
- 53 - 79 : horizon d'accumulation (?) - 10 YR 4/4
couleur brunâtre nettement tranchée-sablonno-argileux;
sur le fond brunâtre, quelques petites plages arrondies
légèrement indurées, de couleur noirâtre (Ø 6 mm),
encore beaucoup de racines et radicelles. friable -
frais - limite très ondulée.
- 79 - 109 : horizon de transition 10 YR 6/4, sablonno-argileux -
sans structure, racines encore nombreuses avec trainées
humifères verticales le long des racines, meuble - frais
- quelques plages de coloration brunâtre, passe graduél-
lement à horizon C.
- 109 - 160 : horizon C. 10 YR 7/4
sablonno-argileux - sans structure - racines rares -
meuble, un peu plus humide.
- 160 - 300 : idem mais gleyifié
sablonneux - nappe phréatique à 300.
- 300 sable blanc grossier.-

Série SP

Podsol à alios humique. Il semble bien que la formation de ces podsols ait été influencé par une nappe phréatique élevée (Ground water podsol). Les caractéristiques sont les suivantes :

- 1) litière épaisse, feutrée et nettement tranchée, composée de feuilles et radicelles peu décomposées.
- 2) un horizon humifère épais et bien développé.
- 3) un horizon délavé, blanchi et d'aspect cendrex (A₂)
- 4) un horizon d'accumulation humique induré, de coloration brun noirâtre (épaisseur 10 à 15 cm), formant un véritable alios.
- 5) sous cet alios une couche brunâtre assez diffuse, présentant de petites plages indurées brun-noirâtres, mais dans l'ensemble, friable à la pression du doigt.
- 6) le dépôt sablonneux (= S₁)

Dans le cas de gleyification, l'horizon gley remonte jusqu'à cet alios. et les plages oxydées présentent déjà une légère induration en leur centre.

Description du profil.

- 0 - 4 : litière épaisse de feuilles mortes et radicelles peu décomposées, feutrée - limite tranchée.
- 4 - 10 : grains de sable blanchâtre dans un fouillis dense de radicelles - horizon légèrement teinté d'humus.
- 10 - 21 : horizon humifère noirâtre 10 YR 2/2, sablonneux - sans structure - fouillis dense de racines et radicelles - très friable - sec - limite ondulante.
- 21 - 32 : horizon humifère moins coloré 10 YR 3/2 quelques grains blanchâtres, sablonneux - sans structure, beaucoup de racines et radicelles - friable - sec - limite diffuse.
- 32 - 63 : horizon d'infiltration humifère 10 YR 3/2 - 4/2 sablonneux - sans structure - grains de sable délavés toujours beaucoup de racines et radicelles - friable - sec - limite ondulante.
- 63 - 78 : horizon A₂ - 10 YR 7/2 - horizon délavé (sable blanchâtre) et d'aspect cendrex, sablonneux - sans structure, encore nombreuses racines et radicelles, friable - limite régulière.
- 78 - 86 : horizon brun-noirâtre 10 YR 3/2, sablonneux, sans structure, meuble - racines et radicelles - limite ondulante.
- 86 - 100 : horizon B₂ 5 YR 4/6 à 7.5 YR 5/6 - horizon d'accumulation humique nettement induré (véritable alios) se fragmente en blocs compacts, subanguleux, quelques racines traversent cet horizon, limite ondulée, l'alios peut devenir plus épais en d'autres endroits. Les grains de sable sont cimentés par les matières humiques; on y observe de petites radicelles pourries.
- 100 - 107 : horizon d'accumulation mais nettement moins induré 5 YR 4/6 friable à la pression du doigt, sablonneux - sans structure. Couleur et induration s'atténuent progressivement.
- 107 - 121 : horizon de transition-encore quelques plages arrondies de couleur brun-noirâtre 10 YR 5/6, encore quelques radicelles.
- 121 - 160 : horizon C 10 YR 6/6, dépôt sablonneux - sans structure - friable.-

D. Série colluvionnaire.

La plaine alluviale est limitée du côté "plateaux" par des colluvions. Ces formations sont constituées de matériel éolien colluvionné, mélangé à des débris du banc ferrugineux. Elles sont caractérisées par leur couleur rougeâtre, l'absence de limon et la présence de petites concrétions latéritiques.

Ils sont indiqués par C sur la carte des sols.

Yangambi, 1e 16/8/1954

B. Soils developed on the old alluvia.

They are different of the former group in that they contain less silt and more sands in the 50-100 and 100-250 micron classes.

Their structure is not as good as that of the former group.

Their colors are more in the range of the Munsell 10 YR whereas that of the recent alluvia is in the range of the 7.5 YR. Two series have been recognized both being clayey sands: K₃ and K₂, K₃ containing more clay than K₂.

C. Soils developed on the alluvia of the tributaries.

The alluvia of the tributaries consist mostly of sand transported from the upland and which is often deposited in a small sandy plain near the confluent with the River.

The following series have been recognized.

1. So

Coarse sand often covered by a layer of peaty material found only in the swampy bottoms along the streams.

2. S₁

Sand rather deep with well defined organic horizons.

3. S₂

Similar to S₂ but with slightly more clay and with well developed organic horizons.

4. S_p

Sand with well developed profile. Showing the presence of a well defined brown B horizon.

5. SP.

Humic ground water podzol with strongly developed and indurated orststein and a leached A₂ horizon.

Drainage classes.

The series which have just been defined on the basis of the nature of the parent material and the degree of evolution of the profile have been converted into mapping units by the consideration of five drainage classes defined as follows:

<u>Class symbol</u>	<u>Drainage status</u>
-	Well drained
a - - - - -	imperfectly drained with mottling and gley appearing between 80 and 100 cm.
b - - - - -	badly drained, mottled near the surface and pronounced gleying at 50 cm
c - - - - -	Temporary swamps
d - - - - -	Permanent swamp

Some of the temporary swamp have a humic layer with definite peaty characteristics. They are indicated as T on the soil map.

It is of course impossible to draw a boundary between the temporary and the permanent swamps.

Rive droite du fleuve Congo

per P. Gilson et P. Jongen

corrélation provisoire





(21)
(20)

JUL

Guide to the second field trip (upland soils)

From the beach, we follow the road taken at the first field trip until we come at the crossway of Yangambi - Plantation where we turn North.

The road we are following now cuts across the grounds of the Research Center from South to North for about 10 miles.

This road is not very interesting from a pedological standpoint since it follows the divides which are uniformly characterized by the Yangambi series. It is easy to see why the road has been traced in such a way, from its state of repair at the few points where it crosses the Y_2 and Y_3 series.

Immediately after the Yangambi crossroad, we go through a rubber plantation which was replanted immediately after rubber. These soils have been under continuous rubber for about 40 years. Then, the road went formerly through old oil palm fields which have been converted into permanent pastures on the right hand side. This site affords an opportunity to see the typical landscape of the region. It should be noted that termite mounds have been almost completely leveled before establishing the pastures and that the original microrelief does no longer exist.

The road cuts then a valley across the series Y_2 and Y_3 (see soil map of the Yangambi sheet). After the Catholic Mission, the residential quarter and the Meteorological Station, we cross experimental fields of oil palm and come to the fields of the coffee department. Only a small part of the experimental fields of this Department can be seen from the road.

Farther north, the Food Crops Department has most of its installations on the left side of the road (breeding, experimentation drying and storing of food crops). After this, we note on the left side of the road a succession of strips 100 m wide of forest and fallow. This is where the experimentation started and is being continued on the corridor system of agriculture.

Before leaving the grounds of the Station we notice on the left side of the road the new fields of the Oil Palm Department (plant breeding only).

The road goes then across several Turumbu villages to the Weko crossroad where we turn West to Olembe.

Between Olembe and a small stream, we examine a typical catena of the region where profiles have been dug in the Y_1 , Y_2 and Y_3 series and in the flat of the valley bottom.

(21)

SUMMARY OF THE EXPLANATORY NOTICE OF THE WEKO-GAZI
SHEET OF THE YANGAMBI REGION SOIL MAP

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PART ONE INTRODUCTION.

SITUATION.

The area covered by this sheet is about 85.000 acres on the Congo-Aruwimi divide (Province Orientale, Isangi Territory). The elevation ranges from 1200 to 1600 feet above sea-level.

GEOLOGY

The relief of the Yangambi area is not very pronounced. The unconsolidated superficial formations are scarcely more than 300 feet above the level of the river which is at an elevation of about 1,200 feet.

All one sees is a sandy soil of slightly varied colour; outcrops of rock and cliffs are exceptional. The impression of uniformity is stressed by the equatorial forest cover.

Three main groups of features make up the scenery:

- a) The valley of the Congo river, with its terraces and, farther north, its confluent with the Aruwimi;
- b) The uplands, with their sandy cover;
- c) Rock and other outcrops of the substratum.

The hydrographic system follows valleys with concave profiles and is determined by the features mentioned.

The river and its terraces

The river flows between islands of alluvial origin, of variable age and evolution, but all geologically recent.

The water-worn gravel in the valley bottom contains a few specimens of lithic industry.

The lower terraces, the upper surface of which is at about 15 feet above water level, consist of sandy loam on scattered beds of gravel, and limonitic debris.

Terraces at a level of 50 to 70 feet above the river consist of leached yellow or white sand, on a bed of shiny silica gravel. The sand bed is several metres thick.

Terraces at a level of about 100 feet above the river consist of yellow ochre sand on a bed of dull quartz gravel. This gravel bed is about 70 feet above the level of the river.

The sandy uplands.

The topography of the uplands is subhorizontal and slightly undulating. The slopes are a little more pronounced where the uplands join the terraces. The uplands consist of a thick cover of reddish yellow clayey sand, anything up to a few hundred feet in depth.

On account of its granulometric composition, its homogeneous character, both vertically and horizontally, the absence of any strata formation, and its general layout, this formation is thought to be of aeolian origin. At one point, wind worn stones have been found at the base of this cover. Microscopic analysis of the sand does not however give a clear indication, as most of the grains are somewhat worn.

The sand cover rests on an eroded surface, the more or less disintegrated remains of a sesquioxide accumulation zone (limonite). This iron enriched layer reaches a depth of 15 to 30 feet, in those places where it is still in a fair state of conservation. It is of both alluvial and illuvial origin, for it contains stratified accumulations of gravel, conglomerated nodules, and in-situ precipitates.

This iron enriched layer is widespread; along the river, it is to be found some 130 feet above the water level and it rises up to the few rocky outcrops on the divide between Congo and Aruwimi. It was formed at an extreme stage of peneplanation, in semi-submerged conditions.

The Yangambi formation.

The existence of this sediment formation was already suspected by J. HENRY in 1923. It was only defined quite recently. It only appears clearly in the cliffs along the river, up river from Yangambi (north bank) and near Elisabetha (south bank).

It is a clearly stratified sandy formation, slightly indurated, containing purplish clayey layers with deep cracks due to dessication. The base (at Elisabetha) rests on a bed of quartz, more or less agglomerated with iron oxide and some bauxite. At Yangambi, the base is below the level of the water, but some beds of gravel are to be found at the foot of the cliffs.

At the top, the formation seems to merge into the layer of limonitic concretion. There may be a horizon of wind worn pebbles there. There is a high percentage of round, dull wind worn grains, reaching 75 % in some horizons and the depth of the dessication cracks is quite remarkable. The pebbles encrusted at the foot of the cliffs are not wind worn, however. It is believed that the Yangambi sediment formation may have deposited in a closed basin under desert conditions.

The Karroo.

The triassic, or jurassic Karroo is quite visible in the Stanleyville area. The layers slope down towards the west and at the level of Yangambi they disappear under recent formations. They consist of soft sandstone, argillite, chalky sandstone, red or green shale, and bituminous layers. The Stanleyville layer contains fossil insects and fishes.

The rock substratum.

The rock substratum appears in a number of isolated outcrops and at the bottom of certain valleys.

Red sandstone and early paleozoic or precambrian limestone of the Lindi group appear in outcrops in the large valleys of the Aruwimi, the Lindi and the Tshopo. The hard rocks form remarkable series of waterfalls and rapids (Yambuya rapids, Tshopo falls, Lindi rapids, Wagenia fisheries).

The Lindi group contains a glacial formation of tillite blocs. The sedimentary formations of the original central African shelf seem to be devoid of fossils and are thus difficult to date.

Stratigraphic joins and the age of formations.

The only available data to determine the age of the post Karroo formations of the Yangambi region are:

- 1) the extent of the layer of limonitic concretions and its geomorphological situation;
- 2) the joining up with neighbouring formations;
- 3) the few specimens of stone age industry..

The layer of limonitic concretion found under the aeolian cover of Yangambi extends to the east, beyond the river area and seems to spread over one of the main peneplains of central Africa. This peneplain is generally considered as belonging to the end of the pleistocene. The limonitic concretions would therefore generally mark the limit between the pliocene and the pleistocene. Needless to say that such an assessment is very approximate.

The river terraces do not provide any connexion with other basins. Regional factors (epirogenetic deformations, the nature of the substratum, etc.) play a predominant part.

The sand cover of the uplands can be compared to the Salonga series, in the Tshuapa, and related to the lower pleistocene. The sediment formation of Yangambi can be compared with the Lodja series and the Opala conglomerate. It certainly belongs to the upper tertiary, probably the pliocene.

It will no doubt be observed that no mention has been made of the Kalahari system. This is because no knowledge is yet available in respect to the stratigraphic relationship between the formations of the Congo basin and those of the Kasai-Kwango, of the Rhodesias and of Southern Africa, where the Kalahari system appears in typical form.

This name has moreover been wrongly applied to all sand covers, without any consideration of their age or of their various morphological positions. It is desirable that the use of the word Kalahari should be restricted to siliceous formations and the thick aeolian sand layers of the mid-tertiary peneplain, such as can be observed in the south of the Congo basin.

Climatic variations, paleosols.

The post-Karroo formations of the Yangambi area throw light on important climatic changes that have taken place between the Neogen era and the present time. Briefly, they are as follows, in chronological order :

Lateritic changes (bauxites, etc.) pre-Yangambi series = hot and humid climate.

Yangambi series (Pliocene?): proper desert climate.

Layer of limonitic concretions : variable climate, semi-drowned topography, chemical transportation.

Sandy uplands covered over (lower Pleistocene?): aeolian formations, desert or Saharian steppe.

75 to 100 feet terrace flats (Middle Pleistocene?) ridges dismantled by the action of rivers, humid climate.

Terraces at 50 feet and below, white sand, lower terrace: climate bordering on present day climate.

A number of other climatic changes may obviously have taken place between these and not yet been detected.

The various periods have left their mark, not only in the form of sediment deposits, but also in the form of paleosols. Many paleosols are interspersed in the Yangambi series; the layer of limonitic concretions is a complex paleosol, the surface of the high sandy plateaus went through a long period of evolution during which the soil formation process penetrated in depth. Even on certain recent surfaces such as the Lilanda sands, soils have formed which appear to be partly fossile.

In order to reach a correct interpretation of a modern pedologic profile in modern climatic conditions, various factors must be taken into account :

- 1) the parent material, which is often an old soil, more or less complex, which has evolved through a long period in different climatic conditions, rather than the original bedrock;
- 2) the period of evolution, according to whether the morphological surface is more or less recent or more or less weathered.

CLIMATE

The climate of the Yangambi region has been described by E. BERNARD as follows :

Owing to its geographical position in the heart of the African Continent, Yangambi (0°49'N 24°29'E elevation 1.600 feet) affords an interesting example of an equatorial continental climate, the ombrophilic characteristics of which are much more attenuated than might be expected from its situation in the center of the "Guinean Forest Province".

Global daily radiation, as well as insolation, are relatively small. Yangambi receives a yearly average of 1.952 hours of sunshine, which is 45 % of the theoretical maximum. The average rainfall data (see also table given below) illustrate rather well the double periodicity, characteristic of equatorial regions. There is however a striking dissymetry in the rainfall distribution between the solsticial minima and also between the equinoxial maxima. Indeed, the January - February season is clearly the driest where as the second minimum - in June - is marked. The small rainy season is well pronounced in May, while the main rainy period goes from September till November, with a maximum in October.

According to these average figures, rain seems to be very well distributed over the whole year. An annual sheet of water, 1875 mm or 73,8 inches thick, is distributed over the different months of the year, with a minimum of 94 mm (3.7 inches) in February, and a maximum of 241 mm (9.5 inches) in October.

But these average values conceal the high variability from year to year: very dry spells, scarcely interrupted by a few small rainfalls, happen frequently between half December and the end of March.

Climatological data, observed at Yangambi Km 5, during the period 1940 - 1950 (Annual Report INEAC 1951)

Month	Precipitation in mm	Temperatures (C°)		
		Daily aver. minima	Daily aver. maxima	General average.
January	96	19.5	29.9	24.7
February	93	19.8	30.7	25.3
March	152	20.2	30.1	25.5
April	152	20.2	30.4	25.3
May	183	20.0	29.7	24.9
June	131	19.8	29.3	24.5
July	161	19.2	28.1	23.7
August	168	19.2	28.3	23.8
September	176	19.4	29.1	24.2
October	239	19.4	29.4	24.5
November	188	19.7	29.3	24.5
December	125	19.6	29.2	24.4
Year	1.864 mm	19.7 C°	29.5 C°	24.6 C°
	73.4 inches	67.5 F°	85.1 F°	76.3 F°

PEDOLOGY

The zonal soils have been formed by the prolonged weathering of the aeolian deposit which left as a residue, quartz sand, kaolinite clay and free iron oxides.

All or nearly all the soluble constituents have been either concentrated in the forest vegetation or leached out of the highly permeable sediment toward a very deep water table.

The present pedological process gives rise to a slight textural and structural B horizon between 30 and 60 cm.

PART TWO - THE SOIL MAP.

The soil map is a reconnaissance map in the sense of the Soil Survey Manual. The boundaries between the mapping units are intrapolated from observations made on traverses distant from 500 to 1000 m. This intrapolation is not entirely arbitrary since it is based on the observed relation ship between the landscape forms and soil series. Aerial photographs are used in drawing the boundaries as well as in locating the lattice of traverses which will be cut across the forest.

The following table summarizes the classification of the series according to the parent material.

Parent Material	Landscape unit	Main characteristics	Series Name	Map symbol
		Clay % Munsell Colour		
Lower Pleistocene aeolian deposit and derived formations				
Autochthonous aeolian sands of Yangambi	Lower Pleistocene accumulation: surface	30 to 40 : 7.5 YR 4/4 to 7.5 YR 5/8	Yangambi	Y ₁ and Y ₀
Autochthonous aeolian sands of Yambau	"	more than 40 : 5 YR 4/4 to 5 YR 5/8	Yambau	Y
Clayey sandy colluvia in closed depression:	"	more than 50 : -	Olembe	O
Redistributed sands	Shelves	20 to 30 : 10 YR 3/2 to 10 YR 5/8	Yakonde	Y ₂
Redistributed sands	Shelves : (terraces ?)	20 to 25 : 10 YR 4/2 to 10 YR 6/4	Lombo	L
Recent Colluvia	Lower valley slopes	less than 20 : 10 YR 3/2 to 10 YR 5/6	Isalowe	Y ₃
Alluvia of the Congo and Aruwimi tributaries				
Alluvia	Swampy flats of valley bottoms	coarse sand : white to gray	Boonde- Boto Complex	A T

This table is almost self explanatory.

The classification of the series is based on the recognition of four parent materials.

- Autochthonous aeolian sands
- Redistributed aeolian sands
- Recent colluvia
- Alluvia.

It has been necessary to distinguish two kinds of autochthonous aeolian sands since there is more clay in the deposit farther North. It should be noted that a profile is only classified in the series corresponding to a given parent material if the thickness of the parent material is greater than 60 cm. Only the Yangambi series is subdivided in two phases, the thin phase (Y₀) where the sandy overlay is not thicker than 20 cm and the deep phase (Y₁) where its thickness varies from 20 to 60 cm.

NOTICE EXPLICATIVE DE LA CARTE DES SOLS ET DE
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LA VEGETATION DE LA PLANCHETTE GAZI-WEKO
=====

par

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Première partie: GENERALITES.

1.- Situation et superficie.

La planchette Gazi-Weko de la carte pédobotanique de la région de Yangambi couvre une superficie de 34.400 Ha et se situe dans la Province Orientale du Congo Belge, sur le territoire d'Isangi. Elle chevauche la crête de partage Congo-Aruwimi à hauteur de Yangambi.

Elle est traversée en direction N-S par la route Yangambi - Gazi, qui se prolonge par la piste de Gazi à Yambuya. La route Lilanda-Yambaw-Weko-Bengamisa traverse la carte de l'E à l'W.

Par rapport au niveau de la mer, l'altitude varie de 400 à 500 m; la hauteur au dessus du niveau moyen du fleuve Congo à Yangambi est de 40 à 125 m.

La plantation Inéac de Gazi ainsi que l'extrémité Nord du domaine du Centre de Recherches de Yangambi occupent une partie de la superficie cartographiée. La majorité des terres appartient toutefois à la tribu Turumbu. Quelques milliers d'hectares de Réserve Forestière y sont également inclus.

2.- Géologie.

Le soubassement de la région de Yangambi a été décrit par de HEINZELIN (1) qui en a établi l'échelle stratigraphique provisoire.-

(1) J. de HEINZELIN, Sols, Paléosols et Désertifications anciennes dans le secteur nord-oriental du Bassin du Congo. Publication INEAC - 1952.-

... .. 118012 ...

Les formations qui apparaissent dans le carré Weko, trop éloigné du fleuve pour porter l'empreinte de ses différentes phases d'érosions, sont loin de montrer la même complexité stratigraphique et paysagique.

Il ne faut donc retenir que les entités du tableau I classées dans l'ordre chronologique proposé par de HEINZELIN; auxquelles sont ajoutés les dépôts colluvionnaires récents.

TABLEAU I.

A G E	SUCCESION STRATIGRAPHIQUE	PUISSANCE
Holocène	Erosions locales; colluvions et alluvions	0 - 3 m
Fin ou épi-pléistocène	Sables ocres redéposés (?)	0 - 10 m
Pléistocène inférieur	Sables ocre jaune	+ 40 m
Limite Plio-Pléistocène	Nappe de concrétions limonitiques	1 à 4 m
Pliocène	Série sédimentaire de Yangambi	?

La série sédimentaire de Yangambi est composée de dépôts très hétérogènes, principalement sablonneux, à strates subhorizontales ou obliques, déposés dans un bassin de sédimentation lacustre sous un climat aride à semi-aride. Elle est recouverte par un banc ferrugineux fin-tertiaire, qui englobe dans un ciment des matériaux d'origine diverse, tels que graviers roulés, agglomérats subanguleux de grains de sables, grains de quartz blancs, etc...

Cette formation latéritique ne se présente que rarement à l'état non remanié et n'affleure presque jamais. Elle est uniformément recouverte par le dépôt éolien des sables ocre-jaune qui masquent sa topographie. (Altitude du banc au dessus du fleuve: Gazi 65 m; rivière Lotembo 45 m; sondage Yambaw 95 m).

Ces deux unités n'interviennent jamais dans la formation des sols; la présence de débris latéritiques et d'éléments provenant de la série sédimentaire de Yangambi n'est à signaler que dans les alluvions récentes des affluents du Congo et de l'Aruwimi (moins de 10 % de la superficie cartographiée). La grande majorité des sols dérive donc des sables éoliens jaunes et de leurs produits de remaniement.

Les sédiments issus de cette formation géologique sont à diviser en trois groupes distincts :

- (1) les sables éoliens non remaniés autochtones du pléistocène inférieur,
- (2) les sables éoliens remaniés ou redéposés à situer peut-être dans la fin du/ou l'épi-pléistocène et
- (3) les sables colluvionnaires récents des fonds de vallées. Cette distinction est à la base de la classification des sols.

3.- Géomorphologie.

Les observations faites lors de la prospection pédologique, principalement l'étude des formes du terrain aux endroits déboisés suffisamment ouverts ainsi que les relevés altimétriques sur des percées recoupant dans tous les sens les traits fondamentaux du relief, permettent de reconnaître deux surfaces:

- (1) la surface d'accumulation des sables éoliens du pléistocène inférieur et
- (2) la surface d'érosion actuelle des tributaires du fleuve Congo et de l'Aruwimi, qui se situe dans les couches de la série sédimentaire de Yangambi.

Le premier étage à 115-125 m sur fleuve semble subsister sur de grandes superficies au centre de l'entre Congo-Aruwimi où il est parfaitement horizontal; dans la partie nord-ouest de la carte, cette unité paysagique est inclinée vers le nord et y est repérée par la présence de sols autochtones.

Entre cette surface et le niveau des rivières (65 - 40 m s/fleuve), l'examen des profils de vallée montre -à côté de nombreuses formes intermédiaires à relier principalement à l'âge des cours d'eau, à la nature des dépôts recoupés et à l'action érosive exercée localement par des méandres - deux profils typiques dans la région analysée.

Les replats qui apparaissent dans ces deux profils peuvent être interprétés différemment: il peut s'agir, soit d'un remblaiement par éolien ou d'un colluvionnement d'anciennes vallées ou de dépressions pendant une époque climatique antérieure du pléistocène, soit d'un rajeunissement des rivières, comme c'est probablement le cas dans la vallée de la Lombo où la coupe montre nettement une terrasse.

Ces deux coupes ne font que confirmer l'image déjà présentée par de HEINZELIN au sujet du modelé de la région de Yangambi, image qui combine les deux traits essentiels du relief: vallées jeunes en V développées par un réseau hydrographique actif implanté dans une topographie ancienne où le manque de netteté est absolu.

4.- Climatologie.

L'évolution climatique au cours du pléistocène, l'alternance de périodes pluviales et interpluviales arides à semi-arides parallèlement aux glaciations dans l'hémisphère nord, est suffisamment connue par les travaux des géologues. On se référera pour la région de Yangambi et de Weko à la publication déjà citée.

En ce qui concerne le climat actuel, E. BERNARD (1) le caractérise comme suit :

"Dans la classification des climats du globe, le climat de Yangambi appartient au type Af de Köopen et à la classe B de Thornthwaite. L'indice de précipitation effective de cet auteur y est de 100. Rappelons que le seuil de la classe A des climats super-humides est fixé par Thornthwaite à 128. Cette remarque confirme le caractère continental du climat de Yangambi, caractère que traduit d'ailleurs l'aspect semi-ombrophile de la forêt qui couvre la région.

"La radiation globale journalière et l'insolation sont relativement faibles. Yangambi jouit annuellement de 1972 h. de soleil ce qui représente 45 % de l'insolation possible. Le régime moyen des précipitations reproduit bien la double périodicité propre aux régions équatoriales. Ce régime se caractérise ici par une nette dissymétrie entre chacun des deux minima solsticiaux ou des deux maxima équinoxiaux. Ainsi la saison de janvier-février est nettement la plus sèche de l'année, alors que le second minimum en juin est à peine esquissé. La petite saison des pluies est bien marquée en mai. La grande saison des pluies se produit de septembre à novembre avec un maximum principal en octobre.

"D'après ce régime moyen, les pluies semblent assez bien réparties sur toute l'année. Une lame d'eau annuelle de 1875 mm se distribue mensuellement entre 94 mm (février) et 241 mm (octobre). Mais ces moyennes dissimulent la haute variabilité des régimes annuels successifs. Des périodes de grande sécheresse plus ou moins interrompues par quelques petites pluies se réalisent fréquemment de mi-décembre à fin-mars. Par ailleurs, la seule considération du régime pluviométrique ne peut fournir qu'une image fautive des fluctuations réelles de l'équilibre du bilan d'eau en climat tropical. Malgré la position équatoriale de Yangambi, les importants facteurs de la puissance évaporante de l'atmosphère, température et déficit de saturation de l'air ainsi que cette puissance évaporante elle-même, y manifestent des régimes à amplitude fort nette.

(1) E. BERNARD.- La cadre éoclimatique des recherches sur les plantes vivrières à Yangambi et dans la zone forestière.
Note N°I du Symposium sur les plantes vivrières et leurs méthodes culturales - Yangambi 25/X au 5/XI/50 (Note photocopiée).

Electrotype

La période de février-mars est toute différente sous ce rapport de la période juillet-août."

5.- Population.

D'après les enquêtes politiques menées vers l'année 1930 par l'Administration territoriale, il ressort que la population occupant autrefois le carré Weko était beaucoup plus importante qu'actuellement. Trois groupes de la tribu Turumbu, les Yaelongo, les Yambaw et les Weko, ont parcouru cette région, s'installant de préférence le long des rivières.

Les Yaelongo, après avoir descendu le cours supérieur de la Lubilu, sur la rive droite, ont franchi la crête de partage Lubilu-Boonde pour occuper la tête de source de cette rivière. De là, ils se scindèrent en trois clans: les Yalibwa, qui sont restés en forêt sur la rive gauche de la Boonde, près de l'emplacement de leur village actuel, les Yaselia qui se sont dirigés vers le fleuve Congo sur la rive gauche de la Boonde pendant que les Bokau effectuaient le même mouvement sur la rive droite.

Les Yambaw auraient occupé anciennement la vallée de la Lobuye et auraient progressé ensuite vers l'Ouest jusqu'au village actuel de Yambaw.

En dernier lieu, les Weko, d'origine Mongelima et venant du Nord-Est, se sont installés près de la rivière Lokaye, affluent de la Lotole; ils semblent s'être cantonnés principalement dans le bassin de cette rivière.

La population qui vivait autrefois des produits de la chasse et d'une agriculture très peu développée, est organisée actuellement en paysannat.

6.- Sols.

D'une façon générale les sols zonaux de la carte -c'est à dire les profils bien drainés des surfaces mollement ondulées- se sont formés au départ de l'altération profonde des sables éoliens laissant comme résidus du quartz, de l'argile de nature kaolinitique et des oxydes de fer libre (x).

Tous les constituants solubles ont été soit concentrés dans la végétation, soit lessivés en profondeur dans ces sédiments fort perméables et à nappe phréatique très profonde (plus de 46 m sous le plateau de Yambaw).

L'évolution pédologique, (à part les illuvations d'argile à grande profondeur, qui semblent correspondre à une époque antérieure) donne actuellement naissance à un horizon B entre 30 et 60 cm de profondeur qui se distingue par sa texture, sa structure et parfois par sa couleur.

Kellogg (xx) a classé les sols de la région dans les Reddish-Yellow Latosols et reconnaît aux latosols les caractéristiques essentielles suivantes: rapport silice-sesquioxides bas, capacité d'échange faible à moyenne pour la fraction minérale, faible activité de l'argile, peu de minéraux primaires, peu de matériaux solubles, un degré de cohérence assez élevé des agrégats structuraux, une couleur rouge à rougeâtre du sol.

(x) De LEENHEER L.,-D'HOORE, J. et SYS, K.-: Cartographie et Caractérisation pédologique de la Catena de Yangambi. Publ. INEAC - Sér. Sci. N° 55 - 1952.

(xx) KELLOGG, C.E. et DAVOL F.D.-: An exploratory study of soil groups in the Belgian Congo.- Publ. INEAC. Sér. Sci. N° 44 - 1949.

5. - Conclusion

D'après les données statistiques, on peut conclure que la situation économique de la France est satisfaisante, mais qu'il faut continuer à surveiller de près l'évolution de la situation.

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6. - Bibliographie

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Deuxième partie : LA CARTE DES SOLS.

1.- Notion.

La carte des sols est un document limité aux traits essentiels de la répartition des formations meubles de surface.

Son caractère de carte de reconnaissance est dû en premier lieu à l'imprécision du fond topographique, levé en forêt à la boussole et à la chaîne, en second lieu au fait que les limites pédologiques ne sont repérées que dans des percées parfois distantes d'un kilomètre et sont interpolées en dehors de ces recoupements en fonction d'une loi de répartition.

2.- Base de classification.

Les deux critères à considérer dans la classification des sols, pour l'échelle de travail employée lors du levé de la carte Weko, sont le matériel parental du sol et la classe de drainage. Chaque unité reconnue en fonction de ces deux facteurs reçoit le rang de série et est désignée par un nom de lieu.

Ces unités peuvent être subdivisées en types de sol d'après la texture des horizons de surface ou en phases d'après la profondeur, l'érosion, la pente, etc..

Ce schéma de classification est inspiré des méthodes du Soil Survey en usage aux Etats-Unis d'Amérique (x). La discussion de sa valeur n'entre pas dans le cadre de cette notice explicative.

3.- Classification des sols du carré Weko.

On distingue dans les matériaux de départ des sols :

- (1) sables éoliens autoctones
- (2) sables éoliens remaniés
- (3) colluvions récentes
- (4) alluvions des tributaires.

En ce qui concerne les sables éoliens autoctones on constate qu'ils deviennent plus riches en argile d'altération au fur et à mesure qu'on se dirige vers le Nord. Bien qu'il ne soit pas possible de tracer une limite nette entre les dépôts lourds et plus légers autoctones, ces matériaux ont pourtant été séparés sur la carte en :

- (1a) sables autoctones de Yambaw
- (1b) sables autoctones de Yangambi.

D'autre part des zones de colluvionnement en dépression fermée, près du marais Liwe à Olembe, nous permettent de distinguer en plus un sédiment argilo-sablonneux:

- (1c) sédiment argilo-sablonneux.

(x) Soil Survey Staff: Soil Survey Manual.
U.S.D.A. Handbook N°18 - 1951.

1. - Notion.

La carte des sols est un document limité aux faits géologiques de la répartition des formations meubles de surface.

Son caractère de carte de reconnaissance est de donner lieu à l'interprétation du fond topographique, levé en 1882 à la base de la chaîne, en second lieu au fait que les limites pédonclées ne sont répétées que dans des parties distantes d'un kilomètre et sont interpolées en dehors de ces recensements en fonction d'une loi de répartition.

2. - Base de classification.

Les deux critères à considérer dans la classification des sols, pour l'échelle de travail employée lors du levé de la carte, sont le matériel parental du sol et la classe de drainage. Chaque unité reconnue en fonction de ces deux facteurs reçoit le rang de sol et est désignée par un nom de lieu.

Ces unités peuvent être subdivisées en types de sol d'après la texture des horizons de surface ou en phases d'après la profondeur, l'erosion, la pente, etc.

Ce schéma de classification est inspiré des méthodes du Soil Survey en usage aux Etats-Unis d'Amérique (x). La discussion de sa valeur n'entre pas dans le cadre de cette notice explicative.

3. - Classification des sols du pays Weko.

On distingue dans les matériaux de départ des sols :

- (1) sables éoliens arctiques
- (2) sables éoliens tempérés
- (3) colluviers récents
- (4) alluvions des tribulaires.

En ce qui concerne les sables éoliens arctiques on constate qu'ils deviennent plus riches en arctique d'altitude au fur et à mesure qu'on se dirige vers le Nord. Bien qu'il ne soit pas possible de tracer une limite nette entre les dépôts froids et plus légers arctiques, ces matériaux ont pourtant été séparés sur la carte en :

- (1a) sables arctiques de Yankow
- (1b) sables arctiques de Yankow.

D'autre part des zones de colluvium sont en répartition formées, près du marais, dans la région, nous permettront de distinguer en plus un sédiment arctico-sablonneux :

- (1c) sédiment arctico-sablonneux.

Les sables remaniés ont été scindés en deux unités d'après la couleur :

- (2a) ocre jaune brunâtre
- (2b) beige pour les dépôts se trouvant plus près de la nappe phréatique.

Les alluvions des tributaires, ne recouvrant que des superficies restreintes, n'ont pas été subdivisées et sont regroupées dans un complexe de sols hydromorphes.

Ces considérations permettent d'établir le tableau suivant où chaque matériel de départ est caractérisé par sa teneur en argile et sa couleur :

TABLEAU II.

CLASSIFICATION DES S E R I E S EN FONCTION DU MATERIEL PARENTAL					
Matériel de départ	Unité naturelle	Caractéristiques essentielles	Nom de la série	Symbole	
		texture : couleur	dérivée		
Dépôt éolien Pléistocène inférieur et produits de remaniement					
Sables éoliens autochtones de Yangambi	Surface d'accumulation : pléistocène inférieur	30 à 40 % d'argile	ocre-rouge	YANGAMBI	Y 1 et Y o
Sables éoliens autochtones de Yambaw	Surface d'accumulation : pléistocène inférieur	plus de 40% d'argile	ocre-rouge	YAMBAW	Y
Colluvions argilo-sablonneuses en dépressions fermées	Surface d'accumulation : pléistocène inférieur	plus de 50%	ocre-rouge	OLEMBE	O
Sables remaniés	Replats	20 à 30 % d'argile	ocre-jaune brunâtre	YAKONDE	Y 2
Sables remaniés	Replats (terrasses?)	20 à 25 % d'argile	beige	LOMBO	L
Colluvions récentes	bas des versants de vallée	moins de 20 %	ocre-jaune brunâtre	ISALOWE	Y 3
Alluvions des tributaires du fleuve Congo et de l'Aruwimi.					
Alluvions	flats marécageux des fonds de vallée	sables grossiers	BLANC à Gris	COMPLEXE BOONDE BOTO	AT

Du fait que la limite qui sépare les sols hydromorphes des sols bien drainés recouvre plus ou moins la transition dépôt éolien-alluvions, le critère "drainage" n'intervient que très peu dans la différenciation des unités pédologiques.

Les sables remanés ont été étudiés en deux unités 3' et 4'.

(3) Sables jaunes remanés
(4) Sables pour les dépôts se trouvant plus près de la nappe phréatique.

Des alluvions des tribunes, ne recouvrant que des sables fins remanés, n'ont pas été subdivisées et sont regroupées dans un complexe de sables hydromorphes.

Ces considérations permettent d'établir le tableau suivant de chaque matériel de départ est caractérisé par sa teneur en argile et sa couleur :

TABLEAU II.

CLASSIFICATION DES SABLES EN FONCTION DU MATÉRIEL D'ORIGINE				
Matériel de départ	Naturelle	Unité	Caractéristiques essentielles	Nom de la tribune
Dépôt de sables hydromorphes				
Sables fins	30 à 40 %	Unité 3'	argile : 30 à 40 %	YANGAMMI
Sables moyens	40 à 50 %	Unité 3'	argile : 40 à 50 %	YANGAMMI
Sables grossiers	50 à 60 %	Unité 3'	argile : 50 à 60 %	YANGAMMI
Dépôt de sables remanés				
Sables fins	30 à 40 %	Unité 4'	argile : 30 à 40 %	YANGAMMI
Sables moyens	40 à 50 %	Unité 4'	argile : 40 à 50 %	YANGAMMI
Sables grossiers	50 à 60 %	Unité 4'	argile : 50 à 60 %	YANGAMMI
Dépôt de sables remanés (3' et 4')				
Sables fins	30 à 40 %	Unité 3'	argile : 30 à 40 %	YANGAMMI
Sables moyens	40 à 50 %	Unité 3'	argile : 40 à 50 %	YANGAMMI
Sables grossiers	50 à 60 %	Unité 3'	argile : 50 à 60 %	YANGAMMI
Sables fins	30 à 40 %	Unité 4'	argile : 30 à 40 %	YANGAMMI
Sables moyens	40 à 50 %	Unité 4'	argile : 40 à 50 %	YANGAMMI
Sables grossiers	50 à 60 %	Unité 4'	argile : 50 à 60 %	YANGAMMI

De fait que la limite qui sépare les sables hydromorphes des sables remanés recouvre plus ou moins la limite entre les sables fins et les sables moyens, le critère "couleur" n'est pas toujours suffisant pour les distinguer.

Pour passer de la classification des matériaux parentaux à la légende pédologique appliquée dans la cartographie de sols du carré Weko, il faut remarquer qu'un profil n'est classé dans la série de sol développé sur un matériel parental déterminé qu'au moment où celui-ci dépasse 60 cm de profondeur. Cette remarque se justifie par le fait que la cartographie de reconnaissance ne parvient pas à délimiter les recouvrements de moindre importance.

Seule la série YANGAMBI est divisée en deux phases, la première, phase mince, Y o, dont le recouvrement léger ne dépasse pas 20 cm d'épaisseur et Y 1, phase profonde, où il varie de 20 à 60 cm.

4.- Légende.

Série YAMBAW

- Y : Profil homogène, argilo-sablonneux, plus de 40 % d'argile à moins de 60 cm de profondeur, ocre rouge.

Série YANGAMBI

- Yo : Phase mince; de 30 à 40 % d'argile à moins de 20 cm de profondeur; ocre rouge.
Y1 : Phase profonde, de 30 à 40 % d'argile entre 20 et 60 cm de profondeur; ocre rouge à ocre jaune brunâtre.

Série OLEMBE

- O : Profil homogène, argilo-sablonneux, plus de 50 % d'argile à moins de 60 cm de profondeur; ocre rouge.

Série YAKONDE

- Y2 : Profil homogène, sablonno-argileux, les horizons de 20 à 30 % d'argile dépassent 60 cm de profondeur; ocre jaune brunâtre.

Série ISALOWE

- Y3 : Profil homogène, sablonneux, les horizons de moins de 20 % d'argile dépassent 60 cm de profondeur; ocre jaune brunâtre.

Série LOMBO

- L : Profil homogène, sablonneux à sablonno-argileux, beige.

Complexe BOONDE-BOTO.

- AT : Sables grossiers alluvionnaires blancs ou sables éoliens grisâtres, hydromorphes à moins de 120 cm de profondeur.

5.- LES SOLS.

SERIE YAMBAW

La série Yambaw regroupe les sols lourds, ocre-rouges, issus du dépôt éolien autochtone de Yambaw. La teneur en argile y dépasse 40 %.

Pour passer de la classification des matériaux dans la légende pétrographique appliquée dans la cartographie de la carte N° 1, il faut remonter au profil N° 1, qui est la base de son développement et un matériel pétrographique de celui-ci dépasse de 10 cm de profondeur. Cette remarque est faite que la cartographie de reconnaissance ne peut pas être faite sans la reconnaissance de moindre importance.

Seuls la série YAMAL est divisée en deux phases, la première phase mince, de 10 cm de profondeur, et la seconde phase épaisse, de 10 à 20 cm de profondeur, ou il varie de 20 à 30 cm.

Série YAMAL

Série YAMAL

Y : Profil homogène, argilo-sablonneux, plus de 10 cm de profondeur, argile à moins de 60 cm de profondeur, cote rouge.

Série YAMAL

Y0 : Phase mince, de 10 à 20 cm de profondeur, argile à moins de 60 cm de profondeur, cote rouge.

Y1 : Phase profonde, de 20 à 30 cm de profondeur, argile entre 20 et 30 cm de profondeur, cote rouge à cote jaune brunâtre.

Série OLONE

O : Profil homogène, argilo-sablonneux, plus de 20 cm de profondeur, argile à moins de 60 cm de profondeur, cote rouge.

Série YAKOMA

Y2 : Profil homogène, argilo-sablonneux, les horizons de 20 à 30 cm de profondeur dépassent 60 cm de profondeur, cote jaune brunâtre.

Série YALOWE

Y3 : Profil homogène, argilo-sablonneux, les horizons de 20 à 30 cm de profondeur dépassent 60 cm de profondeur, cote jaune brunâtre.

Série LOMBO

L : Profil homogène, argilo-sablonneux à sablonno-argileux, beige.

Série BOCHU-BOTO

AT : Sables grossiers argilo-sablonneux, blancs ou saisis, argiles fines, argilo-sablonneux à moins de 100 cm de profondeur.

Série YALOWE

Série YALOWE

La série YAMAL est divisée en deux phases, la première phase mince, de 10 cm de profondeur, et la seconde phase épaisse, de 10 à 20 cm de profondeur, ou il varie de 20 à 30 cm.

*1st soil
classified
Aug. 29*
Le profil suivant est représentatif :

- A₀ 1 cm Litière très peu développée, principalement des racines et des radicelles; quelques feuilles en décomposition.
- A₁₁ 7 cm Horizon humifère, 7.5 YR 4/4, assez net, sablonno-argileux, granuleux bien développé, friable, nombreuses radicelles, frais.
- A₁₂ 16 cm Horizon humifère, 5 YR 4/4, moins net, sablonno-argileux, granuleux à grumeleux, friable, beaucoup de radicelles, frais.
- B₁ 37 cm Transition, 5 YR 4/4, peu net, argilo-sablonneux, grumeleux, plastique, moins de radicelles, frais.
- B₂ 66 cm Horizon illuvial, 5 YR 4/6.8, assez net, argilo-sablonneux, grumeleux bien développé, plastique, peu de radicelles, frais.
- B₃ 94 cm Horizon de transition, 5 YR 5/8, moins net, argilo-sablonneux, grumeleux à granuleux, friable, peu de radicelles, frais.
- C 130 cm Horizon C(?), 5 YR 5/8, argilo-sablonneux, granuleux à grumeleux, peu de radicelles, frais.

Dans cette série la présence de l'horizon illuvial semble assez générale; cet horizon se distingue principalement par sa texture et sa structure.

Situées dans les interfluves de la partie nord-ouest de la carte, ces sols occupent d'importantes superficies et se présentent en de larges plateaux qui descendent assez loin dans les vallées et sont parfois immédiatement bordés par la série Lombo. L'examen des profils y montre alors localement des sols tronqués.

A part ces zones de décapage, ces sols n'ont que peu de variabilité et les surfaces de recouvrement sablonneux ou sablonno-argileux y sont de faible importance.

La texture du sol ralentit la percolation de l'eau lors des fortes précipitations et la surface montre souvent un microrelief typique développé sans doute par ruissellement.

Les termitières occupent sur ces terrains de grandes superficies et sont fortement développées.

SERIE YANGAMBI.

Les sols de cette série se sont développés sur le dépôt éolien non remanié de Yangambi et ne se différencient des sols de la série Yambaw que par la texture et la couleur du sédiment éolien en place.

Cette série est divisée en deux phases: phase mince (Y 0) et phase profonde (Y 1) qui s'est vraisemblablement formée par la lixiviation latérale de l'argile dans les horizons supérieurs sous l'influence de la culture; les recouvrements par des sables remaniés ne doivent cependant pas être exclus.

Le profil suivant est représentatif :

1	1 m	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.
2	7 cm	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.
3	16 cm	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.
4	27 cm	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.
5	66 cm	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.
6	94 cm	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.
7	130 cm	Horizon très peu développé, principalement des radiales et des verticales, quelques horizontales.

On observe que les horizons sont très peu développés, principalement des radiales et des verticales, quelques horizontales.

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Le profil suivant est représentatif :

A ₀	1 cm	Litière peu développée, racines, radicelles et feuilles plus ou moins décomposées.
A ₁₁	5 cm	Horizon humifère, plus ou moins net, 7,5 YR 4/4, sablonno-argileux, bien granulé; friable, nombreuses radicelles, frais.
A ₁₂	10 cm	Horizon humifère, moins net, 7,5 YR 5/4, sablonno-argileux, bien granulé, friable, nombreuses racines.
A ₃	32 cm	Infiltration, peu net, 7,5 YR 5/6, friable, sablonno-argileux, granuleux à grumeleux, moins de racines, frais.
B ₁	72 cm	Transition, peu net, 7,5 YR 5/8, sablonno-argileux, plus ou moins compact, granuleux à grumeleux, moins de racines, frais.
C	120 cm	Horizon C (?), 7,5 YR 5/8, sablonno-argileux, moins compact, granuleux, farineux.

L'existence de l'horizon illuvial B est moins fréquente que dans la série Yambaw; elle subsiste toutefois encore dans les Y o.

Situés sur les plateaux bien drainés de la région, ces sols couvrent de grandes superficies. Les pentes dépassent rarement 2 à 3 %.

La variabilité de cette série est plus grande que celle de la série Yambaw; les zones de recouvrement ou d'éluviation y sont assez importantes et la division en phases se justifie.

La phase mince Yo est occupée par un grand nombre de termitières bien développées.

SERIE OLEMBE.

Sur un plateau caractérisé par les sols lourds de la série YAMBAW se situe un marais fermé, appelé "LIWE" par les indigènes. Il s'agit vraisemblablement d'une zone de colmatage en dépression fermée et le sédiment du marais est argileux blanc contenant toujours des grains de sable provenant du dépôt éolien.

Le pourtour de cette formation hydromorphe qui est limitée au marais proprement dit, est entourée d'une auréole de sols argileux ocre-rouge; la teneur en argile dépasse souvent 50 %.

Vu sa faible superficie, cette série n'est pas décrite séparément.

SERIE YAKONDE.

Les sols de la série YAKONDE sont développés sur un dépôt moins riche en argile (20 à 30 %); la couleur tend vers l'ocre jaune brunâtre et les horizons humifères sont plus épais.

sub peuplé

Le profil suivant est représentatif :

H ₀	2 cm	Litière assez bien développée, principalement feuilles plus ou moins décomposées, radicelles.
H ₁	10 cm	Horizon humifère, plus ou moins net, 10 YR 3/2, sablonno-argileux, peu structuré, meuble, beaucoup de racines.
H ₂	21 cm	Horizon humifère, moins net, 10 YR 4/4, sablonno-argileux, finement granuleux meuble, beaucoup de racines, frais.
H ₃	46 cm	Infiltration, peu net, sablonno-argileux, finement granuleux, friable, beaucoup de racines, 10 YR 5/6.
H ₄	85 cm	Transition, 10 YR 5/8, peu net, sablonno-argileux, granuleux, friable, moins de racines.
H ₅	120 cm	10 YR 5/8, peu net, granuleux, sablonno-argileux, meuble, peu de racines.

L'horizon B n'est généralement pas développé, sauf dans la partie sud-est de la carte où ces sols recouvrent de grandes superficies planes; la couleur du sédiment y est également plus rouge.

La variabilité de cette unité concerne surtout la texture des horizons de surface, souvent sablonneuse. Il n'est cependant pas possible de cartographier ces profils en reconnaissance.

Ces terrains jalonnent en bandes de largeur variable le bord des plateaux et les pentes y dépassent souvent 7 %; à côté de cette situation normale, on les rencontre sur de faibles déclivités.

Les fragments de charbon de bois isolés y sont assez fréquents, même en profondeur.

Les termitières sont très peu développées et sont parfois absolument absentes.

SERIE ISALOWE.

4-3

Ces sols légers, sablonneux, ne contenant que moins de 20 % d'argile entourent, en bandes étroites, les fonds de vallées. Le profil est plus nettement ocre jaune et l'infiltration des matières organiques semble plus profonde.

Le profil suivant est représentatif :

H ₀	2 cm	Litière peu développée, racines et radicelles mélangées aux sables, net.
H ₁	13 cm	Horizon humifère, net, 10 YR 3/2, avec grains de sable blanc, très meuble, sablonneux, sans structure, beaucoup de radicelles.
H ₂	33 cm	Horizon humifère, 10 YR 4/4, sablonneux, sans structure, meuble, moins de racines.
H ₃	55 cm	Horizon d'infiltration, 10 YR 5/6, sablonneux, finement granuleux, meuble, peu de racines.
H ₄	100 cm	Horizon de transition, 10 YR 5/6, sablonneux, granuleux, meuble, peu de racines.
H ₅	120 cm	Sablonneux, 10 YR 5/6, granuleux, meuble, peu de racines, pas net.-

On ne trouve pas d'horizons illuviaux dans ces profils qui semblent uniformes et ne marquent qu'une augmentation légère de la teneur en argile avec la profondeur.

Généralement ces sols reposent directement sur les couches de la série sédimentaire de Yangambi, sans transition par le banc ferrugineux. La couleur du sol dans cette série reste cependant toujours ocre jaune brunâtre à ocre jaune.

La pente est souvent très prononcée et varie de 7 à 15 %. Les fragments de charbon de bois isolés y sont fréquents; localement on note l'existence de profils enterrés sous un manteau colluvial; des débris de poterie se retrouvent parfois dans ces sédiments.

Les termitières sont généralement peu représentées.

SERIE LOMBO.

Cette série réunit les profils légers, tenant de 15 à 25 % d'argile et de couleur beige. Ces sols reposent en profondeur immédiatement sur un sédiment hydromorphe. On les observe sur les replats dans la zone Nord de la région cartographiée.

Le profil suivant est représentatif :

H ₀	2 cm	Litière bien développée, nombreuses radicelles et feuilles en décomposition.
H ₁	14 cm	Horizon humifère, 10 YR 4/2, peu net, sablonno-argileux, meuble, finement granuleux, nombreuses racines, frais.
H ₂	40 cm	Horizon humifère, 10 YR 5/2.3, peu net, sablonno-argileux, meuble, finement granuleux, nombreuses racines, frais.
H ₃	65 cm	Infiltration, 10 YR 5/3, peu net, id.-
H ₄	108 cm	Transition, 10 YR 6/4, sablonno-argileux, finement granuleux, meuble, frais.
H ₅	130 cm	Sol en place, 10 YR 6/4, id.-

Cette entité est assez uniforme quant à sa couleur et à sa texture; on ne rencontre que rarement des profils superposés; les termitières y sont très rares.

COMPLEXE BOONDE - BOTO.

Ce complexe groupe les sols comprenant à moins de 120 cm de profondeur un horizon sous l'influence de la nappe phréatique, blanc ou gris. Développé le plus souvent sur des alluvions sablonneuses, il consiste en un mélange de différentes unités pédologiques dont les principales sont classées et décrites; il contient en outre nombre de petites unités non étudiées.

La série BOONDE y prend la plus large extension. Elle est formée d'un sable grossier alluvionnaire blanc surmonté d'un horizon humifère noir, épais et net; la tourbe n'y est pas rare.

La série BOTO renferme les sols issus de sables provenant des plateaux et accumulés au bas des pentes; des dépôts de la série sédimentaire de Yangambi l'influencent parfois.

Les termitières sont absentes dans ce complexe.

Troisième partie : LA CARTE DE VEGETATION.

§ 1. Principe et Méthodologie.

Parallèlement à la carte des sols, une carte physionomique de la végétation a été dressée; elle vise deux buts bien définis. Il importait d'abord de donner une idée de la répartition proportionnelle des principales formations végétales, de localiser ensuite plus précisément des groupements présentant un grand intérêt au point de vue phytosociologique: les forêt à Brachystegia Laurentii (DE WILD.) LOUIS ex HOYLE et celles à Macrolobium Dewevrei DE WILD.(x) Les associations végétales du Secteur Forestier Central du Congo Belge sont en effet assez peu connues jusqu'à présent et les données fournies par cette carte voudraient permettre de serrer de plus près ce problème complexe.

La méthode du levé est analogue à celle des pédologues et est expliquée plus haut dans la présente notice. Les groupements à Brachystegia et à Macrolobium ont été relevés avec plus de précision.

§ 2. Bases de la classification et légende.

Le climat de la région prospectée implique l'existence d'une végétation forestière. Les groupements qui y trouvent place jouissent de conditions synécologiques fort semblables, le facteur primordial les différenciant est l'intervention humaine et, en second lieu, la hauteur de la nappe phréatique.

Les unités cartographiées se distinguent par leur physionomie, que nous avons pu matérialiser par la dominance de certaines espèces et par l'âge des groupements. Les types suivants ont été retenus :

<u>Dénomination</u>	<u>Symbole</u>
Recrû forestier	V
Parasoleraie	P
Forêts secondaires et remaniées	C
Stade juvénile	m
Stade adulte	a
Forêts hétérogènes à caractère primitif	S
Forêts primitives à <u>Brachystegia Laurentii</u>	B
Forêts primitives à <u>Macrolobium Dewevrei</u>	M
Forêts rivulaires et marécageuses	U

Les mélanges ont été cartographiés en bandes verticales des deux constituants dont l'épaisseur représente l'importance relative de chacun. Les îlots dispersés d'un groupement dans un autre sont représentés en "mosaïque" de petits cercles disposés en quinconce.

(x) Une nomenclature récente (Flore du Congo Belge et du Ruanda-Urundi vol.III, p.428 (1952)), a proposé une combinaison nouvelle : Gilbertiodendron Dewevrei (DE WILD.) J. LEONARD. Dans une publication destinée à un public plus large que les seuls botanistes, nous avons préféré garder l'ancienne dénomination, connue de tous, et dont la tradition a consacré l'usage: Macrolobium Dewevrei DE WILD.

§ 3. Les types de végétation.

1. Le recrû forestier.

Les stades pionniers de la recolonisation forestière se présentent en taillis très touffus, dominés par Vernonia conferta BENTH., Macaranga spinosa MUELL.ARG., Harungana madagascariensis LAM. et Anthocleista nobilis G.DON. Le sous-bois, très dense, est surtout constitué de Zingibéracées (Costus div.spp., Aframomum luteoalbum K.SCHUM., A.Thonneri DE WILD.) et de Marantacées, mêlées à de nombreuses plantes grimpantes (Cogniauxia trilobata COGN., Dioscorea div.spp., Passiflora foetida L., Ipomoea div.spp., etc...).

La dégradation du sol peut conditionner deux séries. La série de l'Hymenocardia ulmoides OLIV., sur sol dégradé, avec abondance de Coinochlamys angolana S.MOORE et d'alchornea Yambuyaensis DE WILD. dans la strate inférieure, présente une végétation relativement claire. La série du Musanga cecropioides R.BR., sur bon sol forestier, a un couvert plus dense et une stratification plus intriquée, les Marantacées y sont abondantes.

Etant donné le peu d'importance territoriale du recrû forestier dans la dition, ces séries n'ont pas été cartographiées.

2. La Parasoleraie.

Dépassant le stade du recrû, l'installation forestière se continue par la parasoleraie. Deux strates se différencient nettement dans ce groupement: la supérieure est constituée presque exclusivement du Musanga cecropioides: le sous-bois est formé des espèces du recrû ayant pu s'adapter à ce nouveau milieu et des pionnières de la forêt secondaire.

Synécologiquement, ce groupement se caractérise par une luminosité atténuée et des gradients déjà bien marqués de température et d'humidité atmosphérique. Il permet le rétablissement rapide d'un microclimat forestier assurant une bonne protection du sol.

3. Les forêts secondaires et remaniées.

Nous avons cartographié sous ce symbole le complexe des stades de transition entre les formations récentes de reconstitution du couvert forestier et la forêt hétérogène adulte. Ces stades, liés dynamiquement et synécologiquement, présentent une grande richesse floristique et peuvent revêtir une physionomie fort diverse. En général pourtant, ils se caractérisent par un dôme inégal, une stratification enchevêtrée et un sous-bois exubérant.

La strate arborescente est constituée d'espèces à croissance rapide et à bois léger: Ricinodendron Heudelotii PIERRE ex PAX, Combretodendron africanum (WELW.) HUTCH. et DALZ., Pentaclethra macrophylla BENTH., Albizzia ealaensis DE WILD., Irvingia grandifolia ENGL., Nous avons pu y distinguer deux stades physionomiques: un stade juvénile à Myrianthus arboreus P.BEAUV. et un stade adulte à Alstonia Boonei DE WILD.

Les stades jeunes ont un sous-bois très dense, dominé par Caloncoba Welwitschii GILG, Bosquiea angolensis FICARHO, Tabernaemontana durissima STAPP, Tabernaemontana penduliflora K. SCHUM., et des Palisota. Plus tard le sous-bois s'éclaircit, les dominantes sont Palisota ambigua C.B. CLARKE, Alchornea floribunda MUELL. ARG. et Haumania Liebrechtsiana (DE WILD. et TH. DUR.) J. LEONARD.

Ces groupements sont fort représentés dans la région. L'agriculture ancestrale des Turumbu et leurs migrations nombreuses l'expliquent facilement. D'autres facteurs néanmoins peuvent être la cause de leur origine ou de leur persistance. De petits villages de chasseurs ou de constructeurs de pirogues s'installent fréquemment à proximité des rivières et remanient ainsi des forêts que l'agriculture aurait épargnée. Les éléphants enfin, en détruisant les jeunes baliveaux et en disséminant des espèces héliophiles (Sarcophrynium Schweinfurthianum (O. KUNTZE) MILNE-REDHEAD, S. macrostachyum (BENTH.) K. SCHUM., Buchnerodendron speciosum GÜRKE), ralentissant l'installation de la forêt adulte.

4. Les forêts hétérogènes à caractère primitif.

Les stades ultimes de la forêt secondaire passent insensiblement à la forêt hétérogène adulte. La physionomie de cette formation peut revêtir des aspects variés: à proximité des rivières elle est encombrée et lianeuse, sur plateau elle est plus lourde et le sous-bois s'est considérablement éclairci. Sa composition floristique est fort variable, Scorodophloeus Zenkeri HARMS toutefois, est présent presque partout. De fortes dominances locales se présentent, nous avons noté les plus importantes: Scorodophloeus Zenkeri, Cynometra Hankei HARMS, C. Alexandri C.H. WRIGHT, ce dernier se localise sur les parties les plus élevées et les lambeaux notés sont probablement un prolongement, le long de la crête Congo-Aruwimi, des formations importantes existant dans le Nord-Est du Secteur Forestier Central. D'autres espèces prennent par endroits plus d'importance, ce sont Polyalthia suaveolens ENGL. et DIELS, Oxystigma oxyphyllum (HARMS) J. LEONARD (syn. Pterygopodium oxyphyllum HARMS), Celtis Mildbraedii ENGL., Gossweilerodendron balsamiferum (VERM.) HARMS, Afrormosia elata HARMS, etc... La dominante du sous-bois est Alchornea floribunda; dans les stades très âgés Geophila obvallata F. DIDR. et Scaphopetalum Thonneri DE WILD. et TH. DUR. apparaissent.

La forêt hétérogène appartient aux forêts semi-caducifoliées (Ordre: Celtideto-Canarietalia, Alliance: Pterygopodio-
odophleion Lebrun (x)). La grande extension de ce type dans notre dition, si proche de l'équateur, étonne à première vue; les facteurs présidant à son origine et assurant sa permanence peuvent pourtant expliquer ce fait. Le climat d'abord, du type continental, est à la limite inférieure des climats de forêt sempervirente. Les sols ensuite, pauvres et filtrants, ne sont pas armés pour résister aux périodes de fléchissement des pluies. Le facteur le plus important enfin, l'intervention humaine, a très fortement remanié la végétation primitive et permet de considérer la majorité de nos forêts hétérogènes comme des formes de transition vers la forêt ombrophile sempervirente.

(x) LEBRUN, J.: - Esquisse des principaux types forestiers du Congo Belge. Cours de phytosociologie tropicale. Univ. Louvain (Texte dactylographié).

5. La forêt primitive à Brachystegia Laurentii.

La forêt à Brachystegia Laurentii appartient à la catégorie des forêts ombrophiles sempervirentes (Classe: Symphonieto-Macrolobietea Lebrun(x)). Le groupement est en général très lourd (les surfaces terrières dépassant 30 m²/Ha ne sont pas rares) et se caractérise par une dominance presque exclusive de Brachystegia Laurentii dans la strate supérieure qui atteint ici 45 m. Dans la strate arborescente dominée, nous notons surtout des Cola, des Garcinia, des Maba, Isolona Bruneelii DE WILD., etc... Les strates herbacée et suffrutescente sont peu denses, Scaphopetalum Thonneri est abondant, Pavetta tetramera DE WILD., et Psychotria cf. brevipaniculata DE WILD. (Germain 8244) semblent caractéristiques.

La synécologie est typique des formations ombrophiles sempervirentes, notons pourtant ici que les Brachystegia sont défeuillés complètement ou en partie par les chenilles pendant une petite période de l'année. La luminosité est fort réduite et la température ainsi que l'humidité atmosphérique sont fortement tamponnées par le couvert.

Malgré le peu d'extension que prend ce type de forêt dans la région, divers faits mettent en évidence le bel équilibre qu'il présente avec les conditions de milieu, notons la forte régénération (on trouve en moyenne une centaine de plantules à l'are, dans les beaux peuplements nous avons compté jusque 855 plantules à l'are !), la régularité des courbes de classe d'âge et la constance remarquable de la phénologie. Le peu d'importance territoriale des forêts à Brachystegia ne peut s'expliquer que par l' "inertie" de ces groupements: croissance lente, dissémination à distance réduite, fortes exigences d'ombre et d'humidité pour pouvoir s'installer. La forêt hétérogène, favorisée par l'occupation humaine d'une part, et n'étant pas sensible à ces facteurs d'inertie d'autre part, a pu prendre ainsi la première place en extension spatiale bien que son équilibre avec le climat ne soit pas satisfaisant (xx).

6. Les forêts primitives à Macrolobium Dewevrei.

Les forêts à Macrolobium Dewevrei présentent un second aspect des forêts ombrophiles sempervirentes (Classe: Symphonio-Macrolobietea, Ordre: Macrolobietalia Dewevrei Lebrun(xxx)). Tant par leur physionomie que par leur habitus synécologique ces forêts sont apparentées aux peuplements à Brachystegia; elles sont pourtant souvent plus lourdes et leur sous-bois est mieux tamponné.

Louis (xxxx) a étudié ces groupements et donne comme caractéristiques Strombosiosis Zenkeri ENGL., Eulophia Sandersiana SUMMERH., Isolona Thonneri DE WILD.. Plusieurs unités phytosociologiques seront à différencier dans cette formation, variant surtout d'après la nature du substrat, nous rencontrons le Macrolobium Dewevrei sur les pentes sableuses aux abords des rivières et également en îlots sur plateaux à sol plus lourd.

(x) LEBRUN, J.: - l.c.

(xx) RINGOET, A.: - La forêt à Scorodophloeus Zenkeri ne peut pas être considérée comme le climax dans la cuvette centrale du Congo. Univ. de Louvain. Doctorat en Sciences Botaniques. Thèse annexe 1950 (Texte dactylographié).

(xxx) LEBRUN, J.: - l.c.

(xxxx) LOUIS, J. et FOUARGE, J.: - Macrolobium Dewevrei in Ess. For. C.B., fasc. 6. Public. INEAC. Coll. in 4° - 1949.

Dynamiquement ces forêts se rapprochent également des groupements à Brachystegia, leur aire d'élection semble pourtant se circonscrire aux sols à bonne alimentation en eau.

7. Les forêts rivulaires et marécageuses.

Ce vocable couvre un complexe de groupements fort différents écologiquement et physionomiquement. Deux types sont rencontrés couramment: l'un sur vallée large, marécageuse, apparenté aux Uapacetalia guineensis (SCHNELL) MANGENOT (x), l'autre sur vallée étroite, sableuse, à sol ferme mais bien irrigué se rapprochant de la forêt hétérogène. De nombreux faciès locaux seront à distinguer, notamment celui à *Raphia*, entretenu par l'indigène qui y récolte du vin et des fibres.

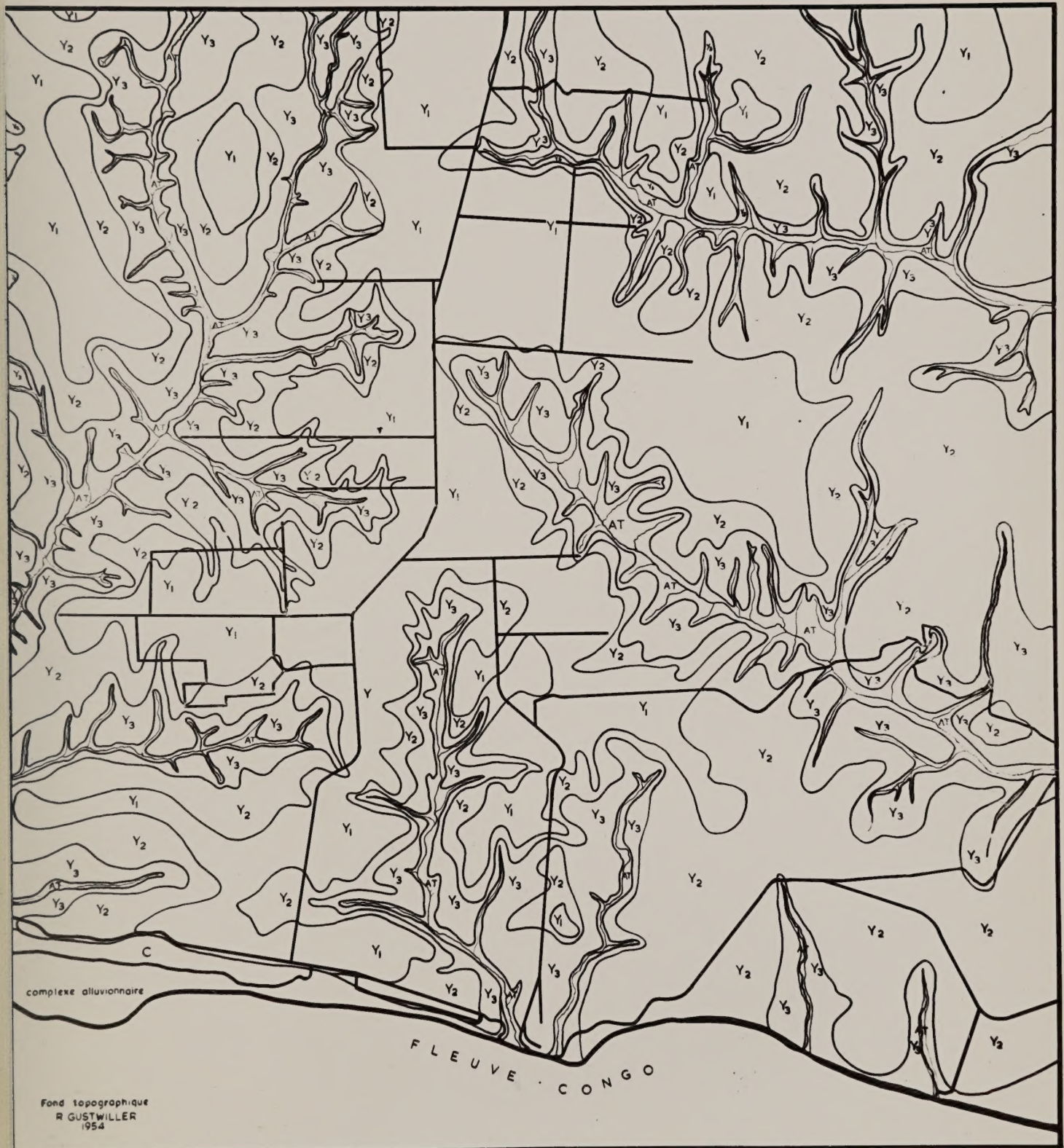
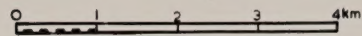
(x) MANGENOT, .- Les forêts de la Côte d'Ivoire.
Bull. Soc. Bot. de France. T.97, fasc.7, p.156 (1950).

YANGAMBI

Planchette 2 : Yangambi

SOLS

par P. Gilson P. Jongen K. Sys A. Van Wambeke



Main outlines of forest research activities.

The Forest research centre of the Forestry Division was established in 1935.

Its main objects of research include the study of tree species and forest formations in the Central Congo district and the establishment of bases of future working plans adequate treatments and exploitations of equatorial rain forest formations.

Experimental field includes experimental sectors in the Yangambi Ineac station and the conservation and future management of reserves (Yangambi and Gazi) amounting to 575.000 acres.

Early works dealt with many aspects of the study of local tree species, forest types and their dynamism and evolution.

The systematic study of tree species is completed to all practical purposes, as well as field study of local forest types.

Collection include more than 13.000 exsiccata (flowers and fruits) 7.500 exsiccata of seedlings at various stages of developpement, dried seeds, fruits and flowers in alcohol. Wood specimens amount to 380 species.

Biological research, started in 1935, investigated the phenology and life cycles of 5.000 local trees visited Weekly for twelve years period. Authentic taxonomical materials have been and are beeing collectea on these observed trees.

All main species of economic value were tried in experimental plantations under various ecological conditions.

Observations derived from these esperimental plantations as well as studies carried out in wild forest conditions have brought out a general knowledge of the biology of these species.

Technological research is carried out in various specialised Institutions in Belgium.

Present and future developpement of forest research bear on forest management and connected problems : plantations, natural regeneration, progressive evolution of wild forest stands, conversion into pure, dense artificial forest stands with species of special economic value, study of forest microclimate and its changes under various operation, particular conditions of natural regeneration. In due course, these works will bring to an adequate knowledge of equatorial rain forest forestry.-

Résumé synthétique des activités de la Division.

Le centre de recherches forestières de Yangambi (Division forestière), rattaché au centre de recherches de Yangambi, a été créé en 1935.

Il a pour but d'étudier les essences et les formations forestières de la cuvette centrale et d'établir les bases de l'aménagement futur et de l'exploitation rationnelle de la forêt équatoriale humide.

Outre ses travaux conduits dans les blocs expérimentaux sis à l'intérieur de la concession Inéac, le centre forestier assure la gestion des Réserves forestières domaniales de Yangambi et de Gazi - Yambuya, qui couvrent quelques 230.000 ha.

Les premières activités du centre forestier de Yangambi furent axées sur l'étude, sous tous leurs aspects, des essences de la région, sur l'étude des associations forestières, des types de forêts, de leur évolution, de leur dynamisme.

L'étude systématique des essences est pratiquement terminée, de même que celle des divers types de forêt de la région. Les collections de la division comprennent plus de 13.000 exsiccata de matériel en fleur ou en fruit, plus de 7.500 exsiccata de plantules, des collections de graines, des fruits et des fleurs en alcool. La xylothèque contient plus de 380 espèces de bois.

L'étude biologique des essences s'est poursuivie depuis le début.

Plus de 5.000 arbres, répartis dans tous les milieux, ont été mis en observation. Ces arbres sont visités chaque semaine pendant 12 années consécutives en vue de recueillir des observations sur leur phénologie et leur rythme de vie. Ils ont fourni et fournissent encore le matériel taxonomique authentique qui alimente les collections.

De nombreuses essences, parmi les plus intéressantes au point de vue économique, ont été mises en culture, éduquées et observées dans les milieux écologiques divers que constituent les parcelles expérimentales. Les observations recueillies dans ces parcelles et en forêt permettent, à l'heure présente, d'avoir un aperçu assez complet sur la biologie de ces essences de valeur.

Quant à l'étude technologique de ces mêmes essences elle est en cours de réalisation dans des laboratoires spécialisés de Belgique.

Actuellement, ces études continuent mais, l'activité principale du centre se porte sur l'aménagement des forêts et la solution des nombreux problèmes qu'il pose. Enrichissements artificiels et régénération naturelle, évolution lente des formations naturelles et transformation radicale et rapide en peuplements denses, homogènes, d'essences de haute valeur économique. Etude du microclimat forestier et de ses modifications, étude des conditions de la régénération naturelle des principales essences et de l'évolution des peuplements. Tous ces travaux en voie de réalisation permettront, d'ici quelques années, d'élaborer les principes de base d'une doctrine forestière pour la forêt humide équatoriale.-

Yangambi, le 29 - 8 - 1954.-

NOTES ON THE ACTIVITIES OF THE DIVISION OF BOTANY.

The purpose of the Division of Botany in the study of the equatorial and tropical vegetation from a floristic and sociological point of view.

Phytosociological research has a double purpose, both scientific and practical in application to agriculture, cattle breeding and forestry.

The studied areas extend to Belgian Congo and Ruanda-Urundi.

The Division includes: Botanists, in charge of floristical, geobotanical and phytosociological research in collaboration with the other activities of the "Centre de Recherches de Yangambi."

Agrostologists, studying the pasture management in savannah-areas (Nioka, Rubona, Gandajika) and in the forest-region (Yangambi).

Horticultural specialists in charge of the collections at Yangambi and Eala Botanic Gardens.

The Division was founded in 1935 by the late Professor J. LOUIS. It was united with the Forestry Division during the war, under the direction of Professor G. GILBERT. In spite of the lack in European staff, the floristic part of its program was fulfilled. The normal activities of the Division were resumed at the end of the war, and the increase of scientific staff allowed its extension. Agrostological research stations were founded in Nioka(1946), Rubona(1952) and Gandajika(1953).

The actual staff of the Division includes :

1/- Europeans (10)

- | | | |
|---------------|--|----------------------------------|
| a) Yangambi: | Chef de Division: R. GERMAIN, Maître de Recherches | |
| | Assistants | : C. EVRARD, Botaniste |
| | | : L. LIBEN, Botaniste |
| | | : R. GUTZWILLER, Botaniste |
| | | : R. DELHAYE, Agrostologue |
| | Adjoint | : W. KESLER, Chef de Culture |
| b) Nioka | : Assistant | : A. TATON, Chargé de Recherches |
| c) Rubona | : Assistant | : G. MICHEL, Agrostologue |
| d) Gandajika: | Assistant | : S. RISOPOULOS, Agrostologue. |
| e) Eala | : Adjoint | : R. DENIS, Chef de Culture. |

2/- Natives at Yangambi (60) :

Commis	: 1
Clerc dactylographe	: 1
Préparateurs	: 2
Aide-préparateurs	: 6
Indicateurs	: 2
Récolteurs-grimpeurs	: 2
Gardes forestiers	: 3
Planton	: 1
Pépinieristes	: 11
Chauffeur	: 1
Capitas	: 3
Travailleurs ordinaires	: 26

I. Activities and installations of the Division at Yangambi.

A. General Congo Herbarium.

The phytosociological investigations of plant societies supposes a thorough knowledge of their components. First of all it appeared necessary to make a general herbarium of the Congo as a reference for phytosociologists. The late Professor J. LOUIS started the floristic exploration of forest vegetation from the very foundation of the Division. His collections (about 17.000 exsiccata) include many nomenclatural types; they are a very valuable material for botanists who are interested in the flora of the equatorial region.

Later, prospections by members of the Division and other stations extended to other phytogeographical areas. The Herbarium of Yangambi contains presently about 70.000 specimens whose duplicates are kept in the Brussels Botanic Garden.

The principal collections are the following: J. LOUIS (17.000), R. GERMAIN (8.200), A. SCHMITZ (4.000), F. HENDRICKX (2.600), W. MULLENDERS (2.500), C. DONIS (2.400), G. MICHEL (2.000), G. MICHEL et J. REED (2.000), J. LEONARD (1.900), H. CALLENS (1.850), G. GILBERT (1.700), R. DEVRED (1.700), L. TOUSSAINT (1.400), A. FLAMIGNY (1.200), A. TATON (1.200), J. LEBRUN (950), H. DU BOIS (800), J. M. VRYDAGH (700), G. HULSTAERT (600), L. LIBEN (500) and A. MICHELSON (500).

The Herbarium of Yangambi is going to become the National Herbarium of Belgian Congo. A very important activity is actually going on : exchanges and loans with Foreign Institutions interested in Central African Flora.

B. Botanic Garden.

1. Isalowe Floristic Reserve is located within the boundaries of INEAC estate at Yangambi and constitutes the essential part of the Botanic Garden. It includes approximately 2.000 Hectares and contains the principal forest types of the region. This Reserve has different purposes.

From a floristic point of view, it allows the observation "in situ" of species from the rain forest. Many forest trees are labelled for didactic purposes and are submitted to phenological and further observations. Moreover, the labelled specimens make it possible to collect additional material from authenticated origin.

From an ecological point of view, it constitutes a first class material for environment study in the rain-forest.

The soil- and vegetation map is presently being established.

2. Systematic collections are for the moment limited to ruderal, aquatic and ornamental species. They are located on the riversides of Isalowe, small affluent of the Congo-river.

The systematic collections will in the future have their place in a forest area of 60 Hectares which is now being established.

3. Ecological collections. In addition to the systematic garden, ecological collections will principally content the pioneer stages of secondary successions and the groups of weeds whose knowledge is necessary to phytotechnicians.

4. Ornamental plants garden. The removal of systematic collections will free the mouth of Isalowe-river and make possible the establishment of a garden with native ornamental species.

5. Agrostological garden. The fodder-grasses and leguminosae are submitted to observations on growth, reproduction, biological type, root-system, etc...

C. Understaken researches.

Two periods mark the activities of the Division at Yangambi.
- The first one, 1935-39, had as purpose the inventory of plant groups and the collection of material so as to have in the herbarium the largest part of phanerogams and ferns of the region. The first phytosociological works in the equatorial forest started at the same time.
- During the second one, which started 1946, a great part of the work was concentrated on sociological and ecological research. The studies are mostly concerned with-on dry land: ruderal societies, forest recolonisation stages after cultivation, primitive forests (Scorodophleus-Cynometra-, Macrolobium Dewevrei-, Brachystegia Laurentii forest).
- in periodically flooded formations and in the river-islands, the study of swamp-forests, aquatic grassland and the different colonisation stages of sand-banks.

Since 1948, the Division started different observations on the behaviour of fodder-grasses and pasture technics. A recently established agrostological group (1953) is concerned with study of artificial pastures in equatorial region; it will be working in close collaboration with Division of Cattle-breeding.

II. Agrostological groups in savannah-area.

The development and improvement of cattle breeding require at the same time the study of feeding problem. INEAC completed some of its zootechnical centres with an agrostological group in charge of pasture research.

The three groups are located in the regions of cattle-breeding: Eastern- and Southern Congo, and Ruanda-Urundi.

The oldest one (1946), at Nioka (High Ituri) is concerned with problems particular to high altitudes (1500 m) and extensive as well as intensive breeding.

The second one (1953), at Gandajika (High Lomami) is concerned with pastoral management of low and medium altitude, where breeding is mostly performed by Europeans.

The last one (1952) at Rubona, studies the pasture problems of overcrowded Ruanda-Urundi, where cattle-breeding is only a native activity.

III. Soil- and Vegetation survey Missions.

Their purpose is the establishment of maps and the study of relations between soil and vegetation in a given area.

Five missions have been achieved: Kaniama (1948), M'Vuazi (1949), Ruzizi (1950), Nioka (1951) and Mosso (1951). Three other ones are working at the present time: on in Bugesera (Ruanda-Urundi), the two other ones in Katanga (Elisabethville and the Lufira-valley).

(24)

PUBLICATIONS DE L'INSTITUT NATIONAL
POUR L'ÉTUDE AGRONOMIQUE DU CONGO BELGE
(I. N. É. A. C.)

MINERAL NUTRIENT IMMOBILIZATION
UNDER FOREST AND GRASS FALLOW
IN THE YANGAMBI (BELGIAN CONGO) REGION

WITH SOME PRELIMINARY RESULTS ON THE DECOMPOSITION
OF PLANT MATERIAL ON THE FOREST FLOOR

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THIS WORK IS THE RESULT
OF COOPERATIVE INVESTIGATIONS CONDUCTED AT YANGAMBI IN 1951
WHILE THE SENIOR AUTHOR WAS A MEMBER
OF TECHNICAL AGRICULTURAL MISSION (MUTUAL SECURITY AGENCY)
TO THE BELGIAN CONGO.

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INSTITUT NATIONAL POUR L'ÉTUDE AGRONOMIQUE DU CONGO BELGE

I. N. É. A. C.

(A. R. du 22-12-33 et du 21-12-39).

L'INÉAC, créé pour promouvoir le développement scientifique de l'agriculture au Congo belge, exerce les attributions suivantes :

1. Administration de Stations de recherches dont la gestion lui est confiée par le Ministère des Colonies.
2. Organisation de missions d'études agronomiques et formation d'experts et de spécialistes.
3. Etudes, recherches, expérimentation et, en général, tous travaux quelconques se rapportant à son objet.

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MINERAL NUTRIENT IMMOBILIZATION
UNDER FOREST AND GRASS FALLOW
IN THE YANGAMBI (BELGIAN CONGO) REGION

WITH SOME PRELIMINARY RESULTS ON THE DECOMPOSITION
OF PLANT MATERIAL ON THE FOREST FLOOR

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THIS WORK IS THE RESULT
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MINERAL NUTRIENT IMMOBILIZATION UNDER FOREST AND GRASS FALLOW IN THE YANGAMBI (BELGIAN CONGO) REGION

INTRODUCTION

The use and conservation of the supply of plant nutrients indigenous to soils of the tropical rain forest present many perplexing problems in land use. The problems arise in designing land use practices which do not permit excessive losses of plant nutrient or a marked decline in productivity during the cropping interval.

Plant nutrient cycles.

In the native rain forest a large proportion of the available plant nutrients is immobilized in living organisms — mostly forest trees and vines. Annually large quantities of plant tissue (mostly leaves and branches) die, are decomposed on the forest floor and return their supply of nutrients to the soil to be readsorbed by other members of the forest flora and fauna. The readsorption of nutrients is so rapid in the rain forest that, in the case of the acid sandy soils studied here, the available supply in the soil is continually kept at an exceptionally low level. Under a plant cover with such high nutrient demands it is unlikely that many nutrients are lost by fixation or leaching.

The agricultural use of the forest soils requires removal of the forest species and substitution of crop plants. The transition interval between forest and cropping often results in the temporary liberation of large quantities of mineral nutrients to the soil and in an accelerated loss of nitrogen, particularly if the area is burned over as is the most frequent current practice. There is, therefore, a possibility of high plant nutrient loss before the cultivated crop is sufficiently large to reimmobilize most of the nutrients. In conventional cultivation practices, however, often the new crop is planted and grown concurrently with the disintegration and decomposition of the forest residues, but even then reimmobilization of all nutrients does not keep pace with mineralization and there exists the possibility of excessive nutrient losses.

Experience has shown that if the land is occupied by cultivated crops too long the productivity markedly declines and the forest

species cannot be readily reestablished. The fundamental causes for the decline in productivity have not yet been established but depletion of available nutrients may well be among the most important. Deterioration of tilth may also be a contributing factor.

Fallow systems.

The cropping practices most frequently employed in the Central Congo Basin permit the return of forest species within 2 to 3 years after the forest is cut, initiating a forest fallow or regeneration period which may continue for about 15 years under government supervision to erratic, indefinite fallow periods where operated entirely by native farmers. This type of soil management is expensive in terms of both soil and labor, but appears to be a practical solution to the soil management problems where land is in good supply, demand is not great for agricultural products, transportation to market and supply is long and costly, and where local fertilizer resources are either non-existent or not developed.

Fallow systems of land regeneration are widely used for diverse specific purposes. In areas of low rainfall clean fallow is used for water conservation and storage. In some areas the production and accumulation of available nitrogen are important aspects of the fallow period.

In forest or grass fallow two factors appear most important in enhancing soil productivity. One is an accumulation of plant nutrients in organic combinations and prevention of nutrient losses by virtue of plant immobilization. The second factor is the improvement of soil structure by virtue of both rest from cultivation and biological activity. In the sandy soils of the Central Congo it seems likely that the former is of much greater importance than the latter.

In forest or grass fallow systems the rapidly growing vegetation immobilizes and accumulates quantities of plant nutrients. When the fallow area is again cleared and prepared for cropping, the fallow plant residues are decomposed or burned and in the process the nutrients are liberated. The relatively rapid release of nutrients permits the new crops to be nourished. If the nutrient release from the fallow crop is too slow the new crop will suffer. If, on the other hand, the release of nutrients is too rapid part of them may be lost before reimmobilization can take place by the crop plants. After the area has been cropped for one or two years the liberation of nutrients from the organic residues becomes slow; nutrients already liberated are used up, are fixed by the colloids, or are lost by leaching; and the crop may suffer because the supplying capacity

of the soil is not sufficiently large. The operator then must either supply plant nutrients by fertilization or return the land to fallow if maximum crop yields are to be obtained.

Fallow systems neither create plant nutrients nor markedly accelerate their liberation from primary sources in the soil. Their chief function is to conserve nutrients and effect immobilization of sufficient quantities in organic combination so that a crop can be well nourished by the plant food biologically or chemically liberated at the conclusion of the fallow period. Plants are good for fallow inasmuch as they perform this function or as they influence soil physical properties.

In the current systems of agriculture in the rain forest area, the conservation and proper utilization of the indigenous supply of plant nutrients is an ever pressing problem. Management practices need be evolved which will maximize the use of the limited supply of plant nutrients in the soil or immobilized in the plant cover. In this respect a knowledge of the magnitude and importance of the several factors which influence or control the nutrient transformations both under native forest and in the fallow systems of soil regeneration might be most helpful in evaluating current practices and in evolving better soil management programs.

Following cropping of latosolic soils in the Congo Basin, regeneration by forest fallow is presumed to be slow. Agricultural supervisors recommend 15 to 20 years for the forest to become firmly re-established and for the soil to have regained its fertility and productivity. This long period is expensive in terms of land use. If it could be shortened the land could be used more advantageously.

Grass fallow has been considered as an alternative for short rotations but little practical information is available upon its probable usefulness for native agriculture. Grasses perhaps approach their maximum usefulness as fallow crops within a very few years. After two to four years the rate of root elaboration reaches a maximum and decomposition of grass residues proceeds as rapidly as the new growth is formed. At this stage a maximum of plant nutrients has been immobilized in organic form and further extension of the fallow period could enhance soil productivity chiefly through improvement of tilth.

Mineral nutrient immobilization may well be the most important factor in evaluating the usefulness of fallow systems. The study reported in part one was made to ascertain the order of magnitude of nutrients immobilized in several forest fallow plots of varying ages and to compare grass with forest as a fallow system.

PART ONE

Mineral nutrient immobilization under forest and grass fallow.

Plant associations.

Numerous species make up the plant cover in the forest fallow of the Central Congo Basin. Moreover, the plant associations change with age of the fallow and are also influenced by management and by the nature of the soil. Since the general objective was the estimation of immobilized plant nutrients, samples were generally taken by compositing many species. Selected areas were cut and weighed green at the sample site and small samples retained for moisture and for chemical analysis.

The establishment of a forest fallow is accomplished by merely permitting the natural forest species to establish themselves during the latter part of the cropping period. When the forest areas are put under cultivation the trees are cut and most of the litter and small branches are burned. Only the large stumps and resistant large trunks remain during the cropping period that follows. In the corridor system the areas are cropped intensively for about two years after which the forest is permitted to re-establish. A typical rotation may begin with maize which is followed by upland rice and then planted to cassava and bananas. The whole operation from cutting the forest to planting to bananas and cassava transpires within a year's time. During the growth and harvest of the latter crop which takes about 2 years the new forest families are permitted to establish.

During the first period of fallow while the native species are establishing themselves cassava and bananas dominate. These plants become intergrown with annual weeds and short fast growing perennials. As the fallow progresses Umbrella (*Musanga cecropioides*) trees tend to dominate the area. The single generation of umbrella trees grows up together and usually forms the upper strata or leaf canopy over the forest fallow areas. At Yangambi, the umbrella trees still remain the dominant species on the area after 15 years of fallow. At some later period, however, the umbrella trees die and other plant associations become dominant.

Sampling sites and procedures.

The sample sites in the more mature forest fallow areas were approximately 10 meters wide and 30 meters long. Approximate boundaries were established by measuring off an area of the above dimensions. Exact boundaries were established by projecting to the ground surface the area occupied by the tops of the umbrella trees confined in the measured area.

For convenience in harvest the plots were subdivided. The vegetation in each subplot was harvested by height strata. Initially, dominant species were separated but owing to extreme local heterogeneity in specie distribution, in subsequent plots, with the exception of Musanga, only composite samples were taken.

All living material was harvested and weighed at the sample site. Leaves were separated from the woody parts and dried and weighed separately. Samples of the several plant materials were retained for moisture determinations and prepared for chemical analysis.

Litter was estimated by determining the quantity of leaf and limb residue on each of five 2 square meter areas chosen at random within the plot. Litter samples were dried, weighed and subsamples retained for chemical analyses.

Estimations of the quantity of roots in the plot soils were made by sampling at random pie shaped areas adjacent to tree locations. The main roots of the umbrella tree branch above the ground and radiate into the soil as far as 1,5 meters from the entry of the main tap root.

When the trees were cut the locations of the main tap roots were noted. Root sample areas were delineated by rotating a radius of 2 to 2,5 meters through an angle of 60°. The inscribed areas were calculated and the root yields for the several soil horizons reported as kilograms per hectare. Samples of roots were also retained for chemical analyses.

Grass samples were taken from small replicated plots established by the Division of Botany and chosen from among the numerous species available in pure stands. *Panicum maximum*, *Setaria sphacelata* and *Cynodon dactylon* ⁽¹⁾ were selected because they appeared to represent those species best adapted for fallow uses. At the time of harvest the grass plots had been established for three years.

Samples from the grass plots were taken by harvesting the total tops and roots from 1 sq. meter areas chosen to represent the mean of the sampled area. The above ground parts were arbitrarily divided into green tops, undecomposed litter and decomposed litter.

⁽¹⁾ *C. plectostachyum* Auct.

The green tops represent all living plant parts above about 10 cm from the soil. Undecomposed litter constituted those non-living plant parts which make up the loose mat on the grass areas. The well decomposed residues still retaining their physical identity were separated and constitute the decomposed litter. These latter residues form a rather thin but somewhat compact mat on the soil surface and are often partly admixed with soil.

Root samples were taken by appropriate soil horizons and were separated from the soil by hand. Because many roots had invaded the surface litter the separation of roots and litter was difficult and often not sharp. Samples of all the harvested material were dried, and prepared for chemical analysis.

Analytical procedures.

In preparation for analyses the samples were dried, ground in a hammer mill and stored in moisture tight jars. For the cations and phosphorus 10 or 20 gram samples, depending upon the expected ash content, were ashed with nitric and perchloric acids and the silica separated by filtration. Samples of the filtrate were used in subsequent analyses. Phosphorus was determined colorimetrically following the method of DICKMAN and BRAY (1). Potassium was determined for the first samples colorimetrically according to the method of KOLTHOFF and BENDIX (3) and then with a PERKIN-ELMER Flame Photometer. Calcium was precipitated as the oxalate at pH 5 after the removal of iron, aluminium and phosphorus. The washed oxalate salt was titrated with standard permanganate. Sulphur was determined gravimetrically as baryum sulphate.

Determinations for magnesium were made on the filtrate from the calcium precipitation after destruction of the excess oxalate with nitric acid. Magnesium was precipitated as the ammonium phosphate and after drying the precipitate the magnesium was determined by titration.

Nitrogen was determined on a separate sample of the plant materials by a standard KJELDAHL procedure. The mineral elements are reported as a percentage of the dry plant material.

RESULTS AND DISCUSSION.

Fallow growth and nutrient immobilization.

The gross dry weights of organic materials and the nutrient uptake are summarized in tables 1 and 2.

A comparison between the several fallow plots and between the fallow and grass plots provides a partial measure of the relative value of the systems.

Nutrient immobilization in the forest fallow is rapid at the onset. In 5 years of forest fallow the quantity of total nutrients immobilized was more than $\frac{1}{2}$ as great as in 18 years. Little difference in total immobilization of nutrients was found between the 5 and 8 years plots. The normal heterogeneity of the area and the error of sampling would easily account for the failure of the results to show significant differences.

In forest fallow the leaf growth rapidly approaches a maximum. Later increases in total growth occur chiefly in the woody parts, particularly the above ground parts.

Roots also approach a maximum at a rather rapid rate. The data show at 5 years 75 % as much growth as at 18 years.

Litter accumulation builds up from leaf and stem residues and closely approaches a maximum some time between 8 and 12 years.

Among the grasses, *Cynodon* made the greater total growth and had the highest nutrient immobilization. The differences among grass species, however, are small and, owing to the small number and size of the samples, may not be significant.

In the grasses a large part of the total harvested material consisted of litter in various stages of decomposition. This is in sharp contrast to either the quantity or proportion of litter in the forest fallow plots.

Total root weight among the grasses was considerably less than in the forest fallow. Grass roots, however, were generally small and fibrous, whereas the major part of the roots from the forest fallow were large and woody.

The total nutrient composition as well as the relative proportion of the several nutrient elements differed among the plant parts. Leaves comprise a small proportion of the total weight of plant parts except at the early stages of establishment of the forest fallow. This is shown by the data in table 3. Living woody tissue, both above ground and roots, account for most of the total weight. In nutrient immobilization, on the other hand, leaves are considerably more important, particularly in uptake and release of nitrogen.

The woody tissues, trunks, limbs and roots, contain the major proportion of all nutrients, except in very early periods of fallow. Woody tissues are particularly important in the immobilization of the cations and phosphorus.

On the grass plots, litter contained the large proportion of the plant nutrients. Grass roots were relatively low in nutrients and accounted for only 10-20 percent of the immobilized plant food elements.

The relative nutrient concentration in the several plant parts are compared to nitrogen in table 4. Leaves and litter in forest fallow

contain relatively more nitrogen than the woody parts. Grass is relatively higher in phosphorus and potassium and lower in calcium and magnesium than forest fallow.

A comparison of the relative extent of nutrient immobilization among the several fallow plots is shown in table 5. Nutrient immobilization like total growth in leaves rapidly reaches a maximum and appears to increase very slowly if at all thereafter.

Roots likewise approach maximum immobilization early in the forest fallow systems. In the woody tissues, on the other hand, maximum immobilization is approached slowly, although the rate of nutrient uptake is most rapid in the early stages of fallow development.

Nutrient immobilization in the grass plots compared favorably with that in the forest fallow (table 6). Grass fallow appears to absorb nitrogen and phosphorus at a more rapid rate in the early stages of development than does forest fallow. Grass, on the other hand, could not be expected to immobilize the large total quantity of nutrients which are found in forest fallow at the later or mature stages of growth. For short fallow systems, grass appears to be equal or superior to forest in nutrient immobilization.

TABLE 1. — Nutrient immobilization in forest fallow.

	Total dry wt. Kg/ha	N Kg/ha	P Kg/ha	S Kg/ha	K Kg/ha	Ca + Mg Kg/ha
17-18 years forest fallow						
Leaves	6,442	143	7.5	17.1	80	76
Wood	114,637	301	62.2	85.8	305	378
Roots	31,240	146	34.2	78.1	200	266
Litter	5,520	75	2.7	9.9	8	66
Dead wood	17,290	36	1.4	5.2	8	36
	175,109	701	108.0	196.1	601	822
8 years forest fallow						
Leaves	5,379	120	6.6	9.0	79	87
Wood	116,313	206	15.3	47.0	579	344
Roots	22,682	152	9.1	35.4	100	127
Litter	7,983	101	4.1	9.2	81	110
	152,515	579	35.1	100.6	839	668

TABLE 1 (*sequel*).

	Total dry wt. Kg/ha	N Kg/ha	P Kg/ha	S Kg/ha	K Kg/ha	Ca + Mg Kg/ha
5 years forest fallow						
Leaves	5,627	125	7.1	15.1	79	78
Wood	71,067	181	13.9	39.1	243	138
Roots	25,753	178	7.7	40.0	113	129
Litter	7,320	79	2.9	9.1	15	70
Dead wood	2,522	4	0.3	—	6	6
	112,289	567	31.9	103.3	456	421
2 years forest fallow						
Leaves and annuals	5,560	80	10.7	11.0	80	63
Wood	5,360	18	6.2	3.9	37	34
Roots and stems	6,939	76	4.9	19.0	65	42
Dead annuals	1,853	15	0.4	3.6	4	21
	19,712	189	22.2	37.5	186	160

TABLE 2. — Nutrient immobilization in grass ⁽¹⁾.

	Yield Kg/ha	N Kg/ha	P Kg/ha	S Kg/ha	K Kg/ha	Ca + Mg Kg/ha
<i>Panicum maximum</i> :						
Green tops	8,260	61	10.8	18.9	150	38
Litter	21,700	234	19.2	31.1	165	114
Roots	9,877	79	6.6	11.1	36	17
Total	39,837	374	36.6	61.1	351	169

⁽¹⁾ Chemical analyses were made only on the first set of grass samples. Weighted means of the mineral composition of the first samples were employed to estimate nutrient immobilization in the second set of samples.

TABLE 2 (sequel).

	Yield Kg/ha	N Kg/ha	P Kg/ha	S Kg/ha	K Kg/ha	Ca + Mg Kg/ha
<i>Setaria sphacelata</i> :						
Green tops	6,910	46	14.1	6.3	95	28
Litter	25,785	261	32.3	47.3	149	111
Roots	7,726	71	8.8	9.4	29	12
Total	40,421	378	55.2	63.0	273	151
<i>Cynodon dactylon</i> :						
Green tops	8,430	68	14.9	21.0	165	46
Litter	25,775	299	27.0	26.7	200	178
Roots	12,093	96	10.4	12.6	58	26
Total	46,298	463	52.3	60.3	423	250

TABLE 3. — Relative dry weights and nutrients quantities
in the several plant parts.

	Total dry wt.	N	P	S	K	Ca+Mg
	%	%	%	%	%	%

17-18 year forest fallow

Leaves	3.7	20.4	6.9	8.7	13.4	9.2
Wood	65.5	42.9	57.6	43.8	50.7	46.0
Roots	17.8	20.8	31.7	40.0	33.3	32.4
Litter	3.2	10.7	2.5	5.1	1.3	8.0
Dead wood	9.9	5.1	1.3	2.4	1.3	4.4

8 year forest fallow

Leaves	3.5	20.7	18.8	9.0	9.4	13.0
Wood	76.3	35.6	43.6	47.0	69.0	51.5
Roots	14.9	26.3	25.9	35.0	11.9	19.0
Litter	5.2	17.4	11.7	9.0	9.7	16.5

TABLE 3 (sequel).

	Total dry wt.	N	P	S	K	Ca+Mg
	%	%	%	%	%	%

5 year forest fallow

Leaves	5.0	22.1	22.3	14.7	17.3	18.5
Wood	63.3	31.9	43.6	38.2	53.3	32.8
Roots	22.9	31.4	24.1	39.0	24.8	30.6
Litter	6.5	13.9	9.1	8.1	3.3	16.6
Dead wood	2.2	0.7	0.9	—	1.3	1.4

2 year forest fallow

Leaves and annuals	28.2	42.3	48.2	29.3	43.0	39.4
Wood and stems	27.2	9.5	27.9	10.4	19.9	21.3
Roots	35.2	40.2	22.1	50.0	34.9	26.3
Dead annuals	9.4	7.9	1.8	9.5	2.2	13.1

Panicum maximum

Green tops	20.7	16.2	29.5	30.9	42.7	22.4
Litter	54.4	62.7	52.5	60.9	47.0	67.6
Roots	24.8	21.0	18.0	18.2	10.3	10.0

Setaria sphacelata

Green tops	17.1	12.2	25.5	10.0	34.7	18.6
Litter	63.8	69.1	58.5	75.0	54.7	67.4
Roots	19.1	18.7	15.9	15.0	10.6	8.0

Cynodon dactylon

Green tops	18.2	14.7	28.5	34.8	39.0	18.4
Litter	55.7	64.6	51.6	44.2	47.4	71.2
Roots	26.1	20.6	19.9	21.0	13.6	10.3

TABLE 4. — Relative amount of nutrients in the plant parts compared to nitrogen as 100.

	N	P	K	Ca + Mg
Forest fallow				
Leaves	100	6	73	65
Wood	100	11	160	125
Roots	100	7	70	80
Litter	100	3	32	100
Grass				
Green tops	100	22	234	63
Roots	100	10	65	51
Litter	100	11	50	22

TABLE 5. — Proportion of plant nutrients immobilized at various intervals compared to the 18 year forest fallow plot.

	Length of forest fallow			
	18 years	8 years	5 years	2 years
Nutrient uptake				
Leaves	100	95	94	94
Wood	100	61	45	9
Roots	100	59	64	27
Litter	100	100	80	19
Mean	100	79	71	37
Total nutrient immobilization				
Nitrogen	100	83	81	28
Phosphorus	100	32	30	21
Calcium + magnesium	100	81	59	19
Mean	100	65	57	24

TABLE 6. — A comparison of total nutrient immobilization among the forest and grass fallow plots.

Fallow plots	N Kg/ha	P Kg/ha	S Kg/ha	K Kg/ha	Ca+Mg Kg/ha
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Forest fallow

18-19 year forest	701	108	196	601	822
8 year forest	579	35	101	839	668
5 year forest	567	32	103	456	421
2 year forest	189	22	37	186	160

Grass fallow (3 years old)

<i>Panicum maximum</i>	374	37	51	351	169
<i>Setaria sphacelata</i>	378	35	63	273	151
<i>Cynodon dactylon</i>	463	52	60	423	250

Plant nutrient supply in the soil.

A consideration of the total supply of plant nutrients indigenous to soils of the rain forest area must include those elements which are associated with soils. Table 7 contains an estimation of the quantities per hectare of plant food content where data were available.

The total supply of nitrogen and phosphorus in the soil is very large in comparison to the quantity immobilized in fallow vegetation. This supply must make some contribution to the available supply and contribute to the growth of plants. Nitrogen in soil is largely tied up in organic combinations and becomes available through biological decomposition of soil organic matter. Nitrogen may also be added to the soil through biological fixation of atmospheric sources.

Some phosphorus is associated with nitrogen in soil organic matter. Estimations using the carbon-phosphorus relationship found in soil organic matter by PEARSON and SIMONSON (5) and the carbon content of Congo soils as reported by LAUDELOUT and D'HOORE (4) indicate the quantity may range between 300 and 700 kg/ha. Soil organic phosphorus is biologically mineralized along with nitrogen and thus becomes available for crop use.

TABLE 7. — Estimations of total phosphorus and of available calcium, magnesium, potassium and phosphorus in two soils near Yangambi compared to nutrients immobilized in the 8 and 18 year forest fallow.

	Forest soil			Cropped soil		Forest fallow vegetation	
	0-15 cm. depth Kg/ha	15-100 cm. depth Kg/ha	Kg/ha	0-15 cm. depth Kg/ha	15-100 cm. depth Kg/ha	8 years Kg/ha	18 years Kg/ha
Nitrogen ⁽¹⁾ (total)	1,500-2,500	3,000-5,000		1,000-1,500	2,000-350	(total) 579	701
Phosphorus ⁽²⁾ (total)	920	4,300		780	3,500	(total) 35	108
Phosphorus (available)	12	40		43	70	—	—
Calcium (exchangeable)	45	250		175	250	(total) 404	578
Magnesium (exchangeable)	27	150		44	150	(total) 264	244
Potassium (exchangeable)	180	1,000		780	1,000	(total) 839	601

⁽¹⁾ Nitrogen was estimated from data by LAUDELOUT and D'HOORE (4).

⁽²⁾ Phosphorus, calcium, magnesium and potassium data were taken from KELLOGG and DAVOL (2).

The exchangeable cations are somewhat comparable in quantity to the amounts immobilized in fallow vegetation. The existence in the Congo soils of a supply of these elements in unavailable form has not been demonstrated. It seems safe to assume, however, that the soils must contain cations in forms other than exchangeable, particularly in the case of potassium. The extent of such unavailable forms and their influence on the available supplies need further investigation.

The rate and conditions of revision of plant foods in the soil from unavailable to available forms have not been clearly elucidated. It seems certain, however, that these so-called « unavailable » supplies are quite important as a source of plant nutrients for fallow crops.

PART TWO

Decomposition and mineralization of plant material on the forest floor.

It was interesting to obtain a partial evaluation of the rate of nutrient release during decomposition in connection with the estimation of total immobilization in plant material described in Part One.

The decomposition processes on the floor of the equatorial rain forest proceed rather rapidly. Leaf residues, even though added continuously throughout the season and in substantial amounts ⁽¹⁾, do not result in litter accumulations comparable to those found in temperate zone forests.

The rapid rates of residue decomposition are the result of a number of factors. Moisture conditions on the forest floor are generally near the optimum for decomposition. Rainfall in the rain forest area is generally high and quite well distributed. Evaporation from the forest floor is slow and the relative humidity of the air near the soil remains near saturation.

Temperature conditions on the forest floor are also favorable for rapid decomposition. The dense vegetation cover serves as a heat buffer preventing the soil from absorbing the intense radiation on bright, hot days and from excessive heat loss during cool weather.

Insect life has a very important function in the disintegration and decomposition of organic residues in the tropical forests. Termites and other insects which attack organic matter are very numerous in and on rain forest soils.

The decomposition of woody tissues is markedly accelerated by the action of insects. Separation of the influence of insects apart from the action of microbes is, of course, impossible. Presumably, insects and microbes compete with one another for certain plant parts and plant constituents but complement each other in the

⁽¹⁾ Observations of the leaf fall during one year indicates that the total amount of plant material returned yearly to the forest floor is :

Forest : 12,300 Kg/Ha.

8 year Forest fallow : 14,200 Kg/Ha.

decomposition of other constituents. The presence of a large insect population in the forest soils and on the forest floor indicates, in part, their importance in the general decomposition process in forest soils.

The rapid initial attack on large woody residues is made by insects. In the utilization of the wood for food or for nests the insects form numerous cavities and interlocking holes and channels. These cavities serve as additional surface areas for attack by microorganisms. Termites, in particular, not only produce large cavities in wood but have the habit of replacing part of the removed woody tissue by soil.

Chemical composition of plant residues also has an influence upon the rate of decomposition under a particular set of environmental conditions. Since there is little litter accumulation in the rain forest it is presumed that all materials are quite readily attacked and decomposed by microorganisms and that none are exceptionally resistant. The experiment reported herein was initiated to provide information on the general rate of decomposition in the forest and to see if there were any wide differences in decomposition rate among a few of the common types of forest leaves.

EXPERIMENTAL.

Plant materials.

Leaf samples were used for experimental substrates because they are the chief plant residue materials deposited on the forest floor. Numerous tree species make up the forest flora. Since only a few leaf species could be utilized in the experiment, selections were made which would include representatives of dominant genera and leaf morphology.

Included with the leaf samples was one sample of grass to provide a comparison between the two types of plant material. The species chosen were :

1. *Gilbertiodendron (Macrobium) dewevrei*.
2. *Panicum maximum*.
3. *Scorodophloeus zenkeri*.
4. *Anonidium mannii*.
5. *Musanga cecropioides*.
6. Composite sample of mixed leaves from forest.

The samples were collected and partly dried. Since climatic conditions prevented air drying sufficiently rapid to impede measurable decomposition, the samples were cut into small pieces and

individual samples weighed while the material was yet moist. A total of 74 individually weighed samples were prepared from each plant material. Of these, 8 were dried and weighed as a measure of initial weight and 64 were used in the decomposition experiment.

Experimental design.

The experimental design consisted of 6 plant material species located at random in 4 replications. Each plant species consisted of 16 individual samples separated by wire mesh in a large wooden frame. At each of 4 time intervals 4 samples from each plant material in each replication were selected at random for determination of dry weight and for chemical analysis.

Frames one meter square with a bronze mesh bottom were used as containers for each sample. These frames were divided into 16 compartments by the use of coarse wire mesh. Each compartment was about 25 cm square and 10 cm in height. The separating wire mesh was of such a size as to minimize interchange or mixing of plant materials but permit the free passage of insects.

The experiment was located in a typical forest area and each frame was placed in a typical undisturbed forest site. Care was taken to minimize the disturbance of either forest undergrowth or the surface litter. After the frames were set and the leaf samples placed in the compartments, leaf litter from adjacent areas was brought in and placed around the frame exterior to provide good insect contact between the forest litter and the decomposition samples. To initiate equal and rapid decomposition the samples were wetted by sprinkling each with about 20 liters of water.

Sample recovery and analysis.

At the following predetermined time intervals samples were removed for determination of dry weigh and for chemical analysis :

Sample No.	Time interval in weeks	Date of Sampling
—	—	—
1st	0	August 21-24
2nd	4	September 17-21
3rd	10	October 30-November 3
4th	20	January 8-11
5th	35	April 22-25

It should be noted that the first, second and third time intervals were during a very rainy season. The weather during the fourth interval, on the other hand, was exceptionally dry, and during the fifth interval the rains were scanty at first and normal at the end.

Because position variation within the frames was suspected the samples at each sampling date were selected at random according to a latin square design. This design permitted some evaluation of position variation if the latter seemed important.

Samples were individually recovered by hand from the compartments in the frames. Each sample was individually dried and weighed. For chemical analysis the individual plant material samples were composited. At the initiation of the experiment 4 sample composites were used for chemical analysis making 2 chemical analysis for each plant material. At the end of 4 weeks decomposition 8 sample composites selected at random were used for chemical analysis again making 2 chemical analyses for each type of plant material. The third sampling at the end of 10 weeks was complicated by the excessive quantities of soil material carried in by termites and admixed with the decomposing plant residues. This contamination by soil was particularly critical in the case of the grass, *Panicum maximum*. In the third sampling two 8-sample composites were used for chemical analysis, but the compositing was not done at random but rather by combining those high in soil into one composite and those low in soil into another. This scheme provided some measure of the influence of soil on the determination of plant nutrients.

After the samples had been composited, subsamples were taken, ground in a hammer mill and set aside for chemical analysis. Chemical procedures outlined in part one were followed.

RESULTS AND DISCUSSION.

The loss of organic matter and the nutrients remaining at the conclusion of the several periods of incubation are shown in table 8.

In order to avoid errors due to contamination of all samples with soil brought in by termites, organic matter losses are expressed on an ash-free basis.

Since the soil of the forest in the Yangambi region is very low in mineral nutrients, the contamination by termites did not greatly influence the results of the chemical analysis of the plant material.

Organic matter losses varied among the plant samples. *Macrolobium* leaves decomposed slowly. The resistance to decomposition may be related to the leathery texture of these leaves and their waxy cuticle which do not allow them to become easily soaked with moisture.

Scorodophloeus leaves and the grass *Panicum maximum* decomposed rather rapidly. Scorodophloeus leaves are small, soft and rich

in nitrogen and behave during decomposition very much as a leafy forage legume. The rapid rate of decomposition of *Panicum* is very likely due in part to the strong termite action on this material.

TABLE 8. — Organic matter loss and liberation of nutrients during decomposition.

Material	Time in weeks	Change in organic matter Ash-free	Nutrients remaining in sample (g per Kg of original material)					
			N	P	S	Ca	Mg	K
<i>Macrolobium</i>	0	1,000	17.5	0.95	1.33	7.9	3.7	10.0
	4	903	19.1	0.72	0.70	7.5	3.7	2.8
	10	720	14.4	0.60	0.63	6.1	2.8	2.0
	20	706	18.7	0.61	1.44	4.9	3.2	0.8
	35	638	19.5	0.42	0.76	5.0	1.6	0.7
<i>Panicum</i>	0	1,000	13.5	1.30	1.50	1.9	2.7	29.3
	4	505	4.5	0.50	0.45	1.4	1.2	2.1
	10	428	6.6	0.54	0.54	1.0	0.7	0.5
	20	362	6.8	0.60	0.82	1.0	2.7	0.5
	35	294	8.2	0.49	0.74	1.1	1.2	0.4
<i>Scorodophlœus</i>	0	1,000	40.0	1.70	12.3	6.0	7.9	14.1
	4	647	20.6	1.05	5.9	5.8	5.2	4.0
	10	465	14.9	0.57	3.7	4.3	2.2	1.4
	20	459	17.0	0.57	4.2	3.3	1.5	0.5
	35	359	14.4	0.49	2.6	1.6	1.6	0.5
<i>Anonidium</i>	0	1,000	28.6	1.27	3.7	7.2	8.5	9.5
	4	621	20.2	0.77	1.5	4.7	4.0	3.2
	10	613	20.4	0.48	1.3	3.3	1.9	0.5
	20	560	23.8	0.57	1.8	3.4	1.2	0.5
	35	550	23.3	0.49	1.0	2.0	0.4	0.4
<i>Musanga</i>	0	1,000	18.9	1.40	2.0	9.5	5.5	13.0
	4	804	16.0	0.82	1.2	9.1	4.2	5.3
	10	552	15.8	0.83	0.8	7.2	2.6	1.0
	20	538	19.7	0.67	1.0	5.2	1.4	0.7
	35	545	20.1	0.59	1.4	6.0	3.9	0.4
Forest leaves	0	1,000	28.6	1.46	5.2	7.0	8.8	14.0
	4	593	17.8	0.60	1.8	4.9	3.8	2.5
	10	436	14.0	0.57	0.4	3.5	1.6	1.0
	20	481	16.2	0.50	2.0	2.0	1.4	0.6
	35	433	17.1	0.54	1.3	2.0	1.1	0.4

Nitrogen losses varied among the leaf samples. The highest losses occurred in samples which were initially high in nitrogen. Musanga and Macrolobium which were lowest in initial nitrogen lost little or no nitrogen during the 35 weeks of decomposition although both materials were extensively decomposed. Among the leaf samples, nitrogen remained in the material at the end of 35 weeks of decomposition to the extent of about 3-4 % of the dry weight of the residues.

The grass, *Panicum maximum*, retained less nitrogen during decomposition than did the leaf samples although it was most extensively decomposed.

Potassium losses were very rapid and included almost all of the initial content. Loss of phosphorus was less rapid than that of potassium but somewhat more rapid than that of nitrogen. The pattern of sulfur loss was similar to that of phosphorus.

Losses of calcium and magnesium were similar in all cases but lower than that of potassium.

The number of fungi and bacteria found in the residues at the several stages of decomposition are shown in table 9.

TABLE 9. — Number of fungi and bacteria in the residues after the several periods of decomposition.

(Fungi in thousands and bacteria in millions per gram of residue.)

Time (weeks)	4		10		20		35	
Plant material	Fungi.	Bact.	Fungi.	Bact.	Fungi.	Bact.	Fungi.	Bact.
<i>Macrolobium</i>	690	35	280	110	337	85	443	132
<i>Panicum</i>	1,290	80	866	604	794	194	2,050	187
<i>Scorodophloeus</i>	291	77	1,300	320	962	157	3,280	236
<i>Anonidium</i>	3,659	773	1,136	297	575	197	565	138
<i>Musanga</i>	2,736	658	607	162	310	100	400	55
Mixed leaves	2,649	672	1,603	295	527	134	936	296

There appears no relationship between the rate and extent of decomposition and the numbers of microorganisms. The rather general decrease in numbers of microorganisms found after 20 and 35 weeks may be due more to the drier conditions prevailing at these times rather than to decomposition of the food materials available for microbes.

Nutrient release from fallow vegetation.

The rate of nutrient release or mineralization from forest residues when the fallow lands are cleared for cropping is an important characteristics of fallow systems. Although this aspect of the fallow plots was not specifically studied, some estimations may be made from data obtained in the decomposition experiment and from a general understanding of mineralization processes in plant constituents. Burning of forest fallow or grass fallow releases the immobilized nutrients immediately. The large part of the bases (potassium, calcium, magnesium, and etc.) and phosphorus are deposited as the oxides on the surface of the ground. Nitrogen, on the other hand, is almost totally lost into the atmosphere as free nitrogen, N_2 , or as the volatile oxides.

When the fallow vegetation is burned an estimation of the nutrients liberated by the above ground parts is simple and direct. An evaluation of the influence of burning on the total availability of nutrients is more complex. Phosphorus, for exemple, when deposited on the soil may be partly fixed in relatively unavailable form before the cultivated crops have a chance to absorb it. Potassium, likewise, may be fixed or it may be lost in the drainage water. Conversely, available nitrogen, because of the elimination of tie-up or immobilization by decomposition of woody tissues, may be higher immediately after burning than where the vegetation is not burned.

Where the fallow vegetation cover is not burned the nutrients would be largely held in organic combination until liberated by microorganisms during the processes of decomposition. An estimation of the rate of release of the various nutrient element is difficult because of the general lack of specific data. Analogous data from temperate climates is likely to be misleading. Data from the decomposition experiments under tropical rain forest conditions permit a partial evaluation of nutrient release during decomposition.

When microbes invade plant tissue and initiate decomposition the easily accessible and available constituents are attacked and decomposed first. Among these plant constituents are the soluble carbohydrates, the proteins and the agents of intermediate metabolism. As a result, the major part of the nitrogen, phosphorus and other plant food elements which were immobilized in plant tissue are rapidly liberated in mineral form. Simultaneously, however, nitrogen, phosphorus and other plant food elements are immobilized in the synthesis of new microbial cell tissue by the invading and decomposing organisms. The net difference between mineralization on the one hand and immobilization on the other represents a measure of the plant nutrients available for use by crop plants.

The size of the microflora initially developing in most common crop residues decomposing under optimum conditions of moisture and temperature requires nitrogen to the extent of about 1,2-1,5 percent of the dry weight of the residue. Less nitrogen is required in the decomposition of woody tissue because of the slower rate of decomposition and development of fewer numbers of microbes per unit of plant substrate. Except where initially high in nitrogen, as decomposition of plant materials progresses the residues tend to become richer in nitrogen. This can be seen by analysis of the data in table 8. The factors responsible for the stabilization of nitrogen are not clearly understood.

Phosphorus is usually required in microbial cell tissue in amounts equal to 6-10 percent of the nitrogen. Potassium, calcium, magnesium and the other essential plant food elements are also necessary for the growth of microbes but they are required in much lower quantities than either nitrogen or phosphorus. Table 10 shows the approximate mineral composition of plant materials compared to that of microorganisms.

TABLE 10. — A comparison of the mineral composition of plant materials and microorganisms.

	Percentage composition				Relative composition			
	N	P	K	Ca+Mg	N	P	K	Ca+Mg
Cereal straw	0.60	0.08	0.90	0.50	100	13	150	83
Corn stalks	0.90	0.10	1.10	0.60	100	11	122	67
Alfalfa	2.20	0.30	1.80	2.20	100	14	82	100
Mixed tree leaves (1) ..	2.45	0.12	1.92	1.67	100	5	78	68
Trunks, branches (1) ..	0.59	0.08	0.70	0.70	100	13	119	119
Musanga	0.16	0.01	0.36	0.24	100	6	225	150
Bacteria (2)	10.00	1.50	0.40	0.80	100	15	4	8
Fungi	5.00	0.80	0.30	0.50	100	16	6	10

(1) Mean composition of forest fallow leaves and woody tissue.

(2) Estimated from data in *Bacterial Chemistry and Physiology* by J. R. PORTER, John Wiley and Sons, New York, 1946.

As decomposition progresses in ordinary plant residues, potassium and phosphorus are lost more rapidly than nitrogen. In plant residues and in microorganisms the ratio of nitrogen to phosphorus

approaches 7-8 : 1. In soil organic matter PEARSON and SIMONSON (5) found ratios ranging from 7,0 : 1 to 15,7 : 1 with a mean of about 9,3 : 1. The litter from the forest fallow plots and litter gathered from the native forest had a nitrogen to phosphorus ratio of about 25 : 1. In the residue from the decomposition of the mixed forest leaves, table 8, the ratio was 32 : 1 and in the decomposed litter from the grass plots, table 2, the ratio was 12 : 1.

Considering the foregoing principles it seems quite unlikely that nitrogen would be rapidly liberated during the initial stages of decomposition of forest or fallow vegetation. Indeed, in consequence of the large quantity of woody tissues on some fallow areas, the decomposing organisms may be expected to initially readsorb a part of the nitrogen mineralized from the surface soil. Burning the fallow vegetation, therefore, may actually result in a better nitrogen supply during the early stages of cropping forest or fallow land than leaving the vegetation to decompose biologically.

The release of phosphorus from decomposing fallow vegetation would be expected to be more rapid than that of nitrogen. Considering the low content in microbial tissue, potassium, calcium and magnesium should be rapidly released during the decomposition process. In the case of potassium this rapid loss has been demonstrated experimentally (see table 8). Calcium and magnesium, however, even though they are liberated and made available, form insoluble salts (carbonates, sulfates and phosphates), and are not removed from the system by leaching and remain as a part of the decomposed residue. This property makes difficult the measurement of mineralization.

Mineralization of nitrogen and phosphorus from grass fallow in general would be more rapid than from forest fallow. Release of potassium from grass fallow would be expected to be similar to that from forest fallow but in each case the rate of release would be related to the total quantity immobilized. Calcium and magnesium, on the other hand, were low in the grass samples examined and therefore could not be supplied rapidly from such fallow systems.

The process of decay of forest or fallow vegetation may not provide a balanced nutrient supply for crop plants. Moreover, it appears most likely that the relative concentration of available nutrients would undergo marked changes during the course of decomposition.

The processes of natural decomposition tend to tie up nitrogen extensively and the other plant nutrients to a lesser extent. The liberation process of any of the elements through biological decom-

position is likely to be slow. It is doubtful that 4-6 months of decomposition of forest fallow residues would result in more than 30 to 50 percent liberation of the potassium or calcium and magnesium and 15-30 percent of the phosphorus. In that same period of time the percentage release of nitrogen may be even smaller than that of the cations or phosphorus.

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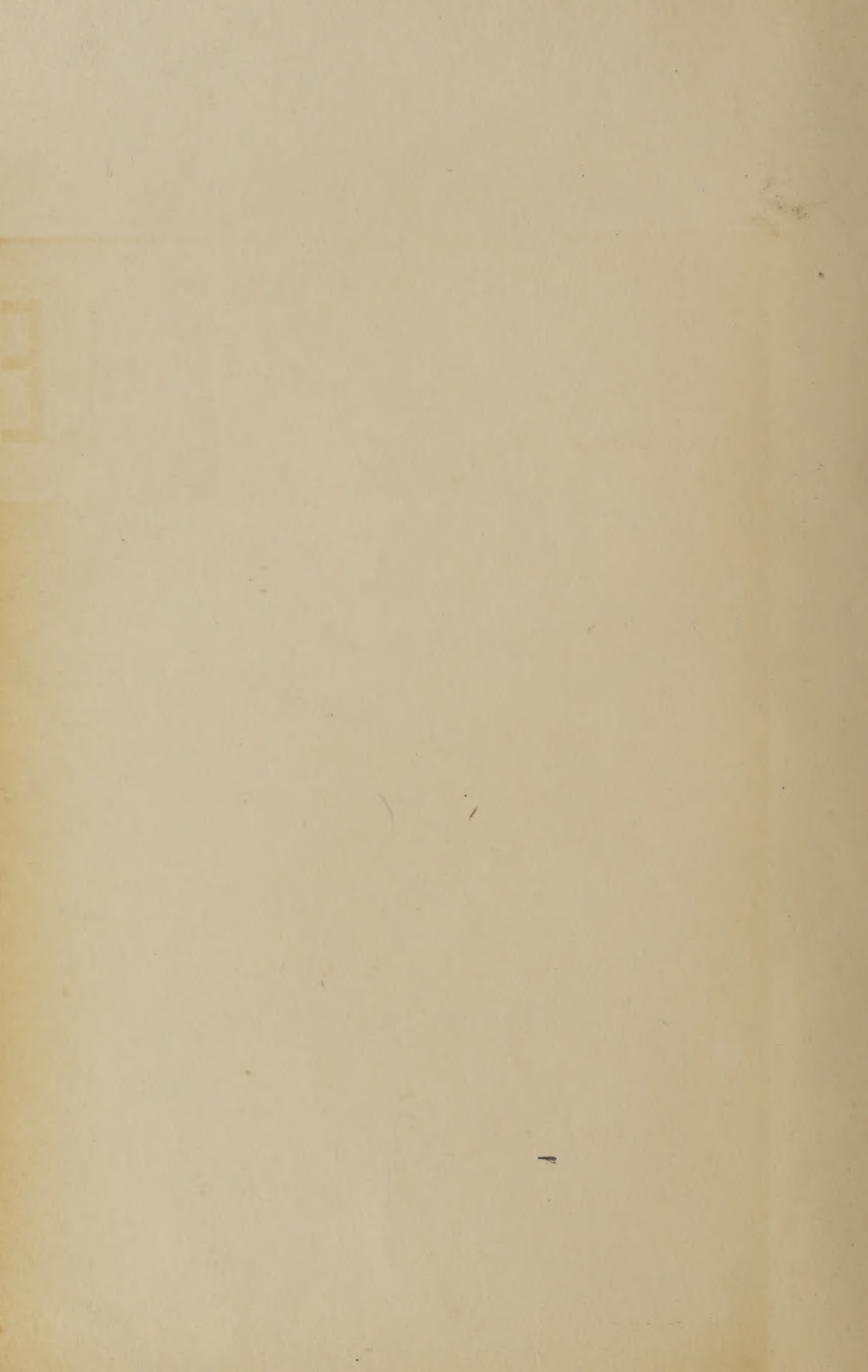
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ELISABETHVILLE

vous attend



SYNDICAT D'INITIATIVE DE LA VILLE D'ELISABETHVILLE
SYNDICAT D'INITIATIVE POUR LE TOURISME AU KATANGA

1954



Elisabethville
...vous attend

Elliot Mills

born 1871

I. — ELISABETHVILLE

ELISABETHVILLE doit son origine et son développement à la découverte d'importants gisements de cuivre et à leur mise en exploitation par l'Union Minière du Haut-Katanga. Elle fut créée à l'endroit appelé LUBUMBASHI (du nom de la rivière y serpentant).

Dès 1907, le Comité Spécial du Katanga, qui assurait, au nom de l'Etat Indépendant et de la Compagnie du Katanga, la mise en valeur du Katanga, se rend compte de l'essor que va prendre l'industrie cuprifère et de la nécessité de disposer d'un centre administratif à proximité immédiate des mines et des usines. Il charge son représentant, Emile Wangermée, de transférer le siège du C.S.K. situé à Lukonzolwa (lac Moero) aux environs de la première mine exploitée (l'Etoile du Congo près d'Elisabethville). A cet effet, le plateau qui domine la Lubumbashi est choisi et le plan d'ensemble de la ville future est établi. Elle prend naissance en 1910, au moment où le rail, venu de Rhodésie, atteint la région. Le nom de la reine Elisabeth fut donné à la nouvelle ville pour commémorer le voyage fait au Katanga en 1909 par S.A.R. le prince Albert, devenu le roi Albert Ier.

En moins d'un demi-siècle, un plateau à peine habité, une savane infinie, hérissée de termitières, mêlée de terre ocre et de végétation maigre, verte en saison des pluies, rouge en saison sèche, sont devenus le siège d'une ville vivante et agréable, d'un centre industriel, commercial et agricole en plein développement et où les possibilités de création d'activités nouvelles restent cependant nombreuses et variées.

Bâtie sur un plan quadrillé, à l'américaine, elle donne l'aspect d'une riche station estivale, tant par la pureté de son climat que par l'aspect heureux de ses villas blotties au milieu de jardins en fleurs.

De ses constructions du début, sans étage, genre bazar rappelant furieusement le Far-West, Elisabethville est devenue une cité charmante, ensoleillée et riante dont les maisons luxueuses, les bungalows fleuris et les squares soignés, n'ont d'égale que la beauté de son parc.

La plus belle partie de la ville est sa périphérie, là où les maisons, dont certaines sont presque des palais, dorment paisiblement dans les jardins, protégées par des allées silencieuses et odorantes.

Et la ville s'étend, s'étire et se modernise à un rythme qui est l'augure d'une magnifique réalisation urbaine dans une des parties les plus riches et les plus vitales du Congo Belge.



II. APERÇU GEOGRAPHIQUE

1. — Situation et Climat.

Elisabethville est située dans la province du Katanga, dont elle est le chef-lieu. C'est la cité la plus méridionale du Congo Belge. Malgré sa proximité de l'Equateur, elle jouit d'un climat tempéré grâce à son altitude de 1.230 mètres qui correspond, approximativement, à la hauteur moyenne des stations climatiques suisses.

L'année ne comporte que deux saisons : la saison des pluies, de fin octobre à mi-avril, et la saison sèche, pendant le reste de l'année. C'est alors que la température est la plus fraîche ; les nuits sont froides et l'on enregistre parfois 0 degré C. au thermomètre. Pendant la journée, la température est agréable toute l'année et l'Européen la supporte sans peine.

Elisabethville est salubre et de nombreux européens s'y établissent.

2. — Population.

Au début de 1954, Elisabethville comptait plus de 10.000 européens et plus de 100.000 indigènes. Les deux communautés, harmonieusement unies pour la plus grande prospérité de leur ville, sont en constant développement.

III. VOIES D'ACCÈS.

Quoique se trouvant au cœur de l'Afrique, Elisabethville n'en est pas moins d'un accès aisé, tant par route ou chemin de fer que par avion.

1. — **Par la route :** la ville est située sur la route axiale transafricaine de grand tourisme Alger (Tanger) — Le Cap.

Une autre voie Nord-Sud emprunte la route du Soudan par la vallée du Nil et Aba, poste frontière du Congo Belge.

Elisabethville est également reliée à l'Océan Atlantique (Lobito via Dilolo, et Matadi via Luluabourg), à l'Océan Indien et au Cap.

Le voyageur débarquant à Mombasa ou Dar-es-Salaam a le choix entre la route pittoresque mais plus longue passant par Kampala, Fort Portal, Beni et le Kivu, Bukavu et Albertville, et la voie plus courte via Abercorn (au Sud du Lac Tanganika) et Kasenga ou Fort-Rosebery-Mokambo.

Venant du Sud (Beira et les ports de l'Union Sud-Africaine) on rejoindra le Congo Belge via Salisbury ou Livingstone (Victoria Falls), Lusaka, Broken-Hill, N'Dola et Sakania.

On travaille actuellement beaucoup aux routes et un important budget leur est réservé au « Plan Décennal ».

2. — **Par chemin de fer :** la voie ferrée relie Elisabethville au reste de la Colonie, aux territoires voisins et aux principaux ports de l'Afrique Centrale et Méridionale. Le rail la met en rapport avec Matadi (x), Lobito, Beira, Durban, le Cap, etc...

D'autre part, la construction de la jonction Kamina-Kabalo améliorera grandement les communications ferroviaires entre Elisabethville d'une part et l'Est de la Colonie et l'Est Africain d'autre part.

3. — **Par voie maritime :** les ports qui la desservent relient Elisabethville à toutes les parties du monde; que ce soit via Matadi-Lobito ou par l'Afrique Méridionale, le voyageur n'éprouvera aucune difficulté à atteindre le Katanga et sa florissante capitale.

4. — **Par avion :** la voie aérienne permet d'accéder directement aux principaux centres du Congo Belge et aux régions environnantes. Des vols nombreux mettent Elisabethville à

(x) Via Luluabourg, Port-Francqui — par bateau jusqu'à Léopoldville, ensuite à nouveau le chemin de fer jusqu'à Matadi. Les travaux de la jonction ferrée Port-Francqui — Léopoldville doivent être entrepris dans un avenir prochain.

quelques heures de la Belgique et des correspondances rapides la font toucher toutes les régions du globe.

La Sabena la dessert avec des appareils de classe « standard » et de classe « touriste » aux tarifs fort intéressants.

Un nouvel aéroport sera prochainement construit, qui permettra l'atterrissage des avions les plus gros, de jour comme de nuit.

5. — Tableau des distances (par la route)

d'Elisabethville à	via	en Kilomètres
En Europe		
Bruxelles	Tanger-Gibraltar	12.700
Paris	» »	12.500
Londres	» »	12.960
En Afrique		
Alger	le Hoggar	9.950
	le Tanesrouft	10.710
Le Caire		7.420
Mombasa	Bukavu	3.510
Dar-es-Salaam	Mbeya	2.510
Beira	Lusaka-Salisbury	1.710
Durban		2.940
Johannesburg		2.260
Le Cap		3.970
Lobito	Dilolo	2.190
N'Dola	Sakania	260
(Rhodésie du N.)		
Au Congo Belge		
Léopoldville	Luluab.-Kikwit	2.780
Matadi	Léopoldville	3.170
Bangassou		3.830
(frontière A.E.F.)		
Aba(frontière Nil-Soudan)		3.200
Stanleyville	Bukavu-Irumu	2.940
Bukavu(Coster- mansville)	Albertville	1.670
Usumbura	Albertville	1.565
Albertville	Manono	1.140
Dilolo	Kolwezi	780
Kolwezi		340
Jadotville		145
Sakania(frontière Sud)		240

IV. — ORGANISATION ADMINISTRATIVE

1. — **L'enseignement :** La liberté d'enseignement est garantie dans les mêmes termes qu'en Belgique. Les établissements scolaires pour européens (x) comprennent les sections gardienne, primaire et d'humanités anciennes et modernes.

2. — **Organisation médicale :** l'organisation médicale est complète; elle compte de nombreux praticiens de médecine générale et spécialisée, et des chirurgiens. Le complexe hospitalier comporte un hôpital officiel avec section de radiographie, un laboratoire de bactériologie et plusieurs dispensaires privés.

3. — **Les cultes :** la liberté et l'exercice des Cultes sont garantis par la Charte Coloniale. Les principaux Cultes actuellement représentés à Elisabethville sont les Cultes Catholique, Protestant et Israélite.

4. — **L'Administration :** Elisabethville est le siège du Gouvernement Provincial du Katanga et le Gouverneur de Province y réside.

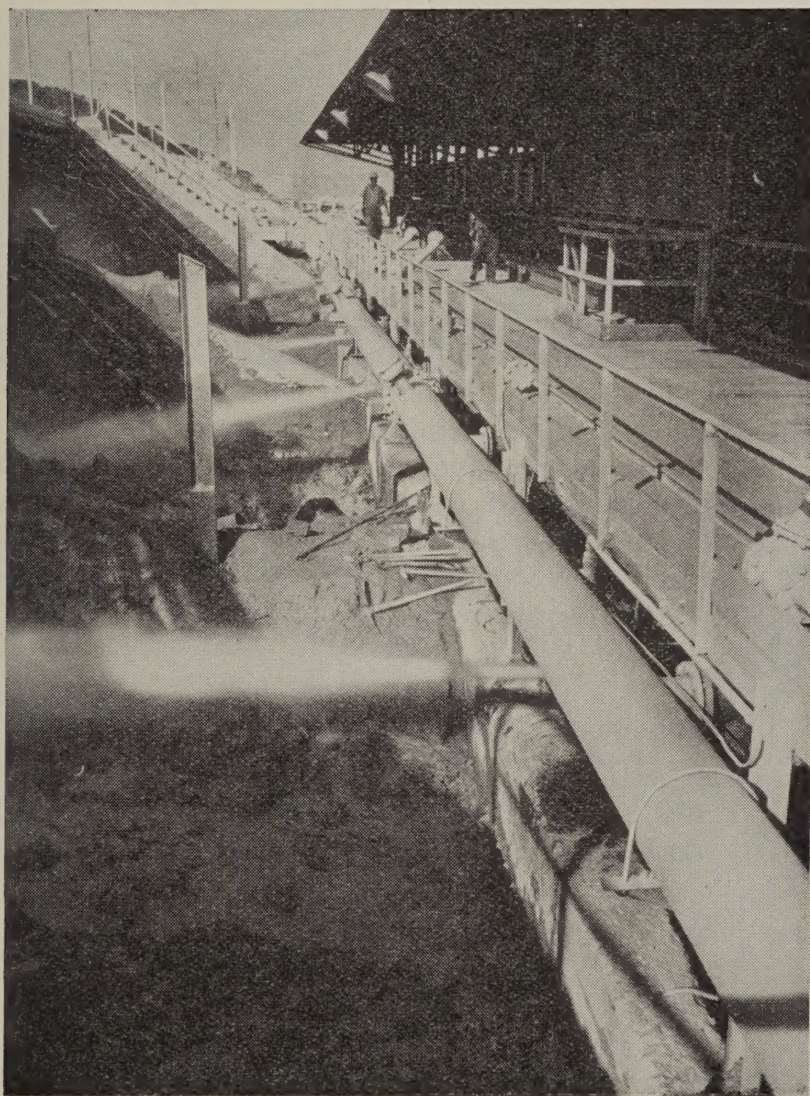
Outre les services administratifs proprement dits (xx), Elisabethville abrite une Cour d'Appel, un Tribunal de Première Instance, des Autorités Militaires, etc...

(x) L'Athénée Royal (enseignement officiel laïc-mixte), le Collège Saint-François de Sales et l'Institut Marie-José (enseignement officiel congréganiste — respectivement pour jeunes gens et pour jeunes filles).
L'Académie des Beaux Arts d'Elisabethville
L'Ecole de Musique

(xx) Administration provinciale — Services dépendant du Gouvernement Général — Administration urbaine.

La ville est dirigée par un Commissaire de District assisté du Comité Urbain.

Le Syndicat d'Initiative se fera un plaisir de communiquer aux voyageurs la liste et l'adresse des services qui les intéressent, ainsi que les noms des personnes à consulter.



Lavage du minerai de cuivre à la mine de Ruwe,
exploitée par l'Union Minière du Haut Katanga.

Photo C. Lamote

V. INFORMATIONS ECONOMIQUES

1. — **Régime économique :** la Convention de Saint-Germain-en Laye garantit l'égalité commerciale aux Etrangers comme aux Belges et aucun traitement différentiel ne peut être imposé aux marchandises importées et exportées.

2. — **Régime foncier :** le Comité Spécial du Katanga (C.S.K.) a la gestion du domaine foncier du Katanga et c'est à lui que s'adressent les amateurs de terrains. Différents organismes et agents d'affaires s'occupent également de transactions foncières.

Les prix moyens pratiqués au début de 1954 dans les transactions immobilières entre particuliers sont de 250,— à 600,— fr. le m² pour les terrains urbains résidentiels; de 1.000,— à 5.000 fr. le m² pour les terrains commerciaux dans le centre de la ville et de 60 à 150 fr. le m² pour les terrains suburbains, dans un rayon de 2 à 5 km du centre.

3. — Principaux grands organismes.

Comité Spécial du Katanga (C.S.K.)

Le C.S.K. assure et dirige en participation l'exploitation du domaine appartenant à l'Etat et à la Compagnie du Katanga dans tout le Katanga. Ses bureaux sont établis au coin de l'Avenue Wangermée et de l'Avenue Kambove.

Union Minière du Haut-Katanga (U.M.H.K.)

L'industrie la plus importante d'Elisabethville est l'usine de l'Union Minière du Haut-Katanga traitant le minerai de cuivre (usine de Lubumbashi). Créée en 1910 elle est en somme à l'origine de la ville, qu'elle a fait naître.



Immeuble à Elisabethville

Photo C. Lamote



Avenue du Kasai à Elisabethville

Photo Y. Kersten



Une avenue d'Albertville (District du Tanganika — Province du Katanga)

Photo C. Lamo

Compagnie du Chemin de Fer du Bas-Congo au Katanga (B.C.K.)
La Compagnie du B.C.K. exploite le réseau ferré Katanga-Dilolo-Port-Francqui (2.355 km).

L'on a entamé en 1952 les travaux de la ligne Kamina-Kabalo, qui doit assurer la jonction du B.C.K. et du C.F.L. (Compagnie des Chemins de Fer du Congo Supérieur aux Grands Lacs Africains). Il a d'autre part été décidé de compléter le réseau B.C.K. en continuant la ligne au delà de Port-Francqui et la relier ainsi au chemin de fer Matadi-Léopoldville; le trajet entre le port national de Matadi et le Katanga pourra ainsi se faire d'une traite et l'on évitera les ruptures de charge à Port-Francqui et Léopoldville.

Les bureaux du B.C.K. sont situés à la place de la gare.

4. — Entreprises industrielles, commerciales et agricoles.

Elisabethville et sa périphérie comptent de nombreuses entreprises industrielles, commerciales et agricoles.

La liste de ces exploitations peut être consultée au Secrétariat de la Chambre du Commerce et de l'Industrie du Katanga (au coin des Avenues de Tabora et du Kasaï, boîte postale No 972, téléphone No 342), qui renseignera les voyageurs et les résidents.

a) **Les industries :** Elisabethville est le siège administratif et partiellement d'exploitation de la plus grande entreprise minière du Congo: l'Union Minière du Haut-Katanga. A Elisabethville, cette société possède l'usine de Lubumbashi qui comprend des hauts fourneaux à cuivre du type Water-Jacket. Le cuivre provenant presque exclusivement des minerais de la mine Prince Léopold, à Kipushi, est coulé en lingots qui sont raffinés en Belgique. D'autre part, cette usine comporte également, entre autres une centrale thermique, un important laboratoire d'échantillonnage et d'analyse chimique, une centrale de pulvérisation de charbon, une installation de mise au teruil, etc...

Une importante usine alimentaire s'occupe en ordre principal de la fabrication des farines de maïs et de manioc, aliments de base de l'indigène.

De nombreuses entreprises indépendantes se sont créées d'autre part, telle une brasserie qui fabrique une bière et une eau de table appréciées.

Des huileries, savonneries, fabrique de bougies utilisent les produits abondamment cultivés ou récoltés par les indigènes des régions avoisinantes.

Des fabriques de limonades, d'eaux gazeuses, de sirops, de vinaigre, de glace et l'industrie du froid trouvent une clientèle suffisante pour faire prospérer leurs affaires.

Citons encore des bonneteries et chemiseries importantes, des usines fabricant des châssis métalliques, des wagonnets, de l'outillage, etc...

De nombreux ateliers de menuiserie, ébénisterie mécanique, chaudronnerie, plomberie, tréfilerie, clouterie, fonderies, fabrication de chaussures, vulcanisation de pneus, etc... sont la propriété de petits patrons et sont alimentés à plein rendement par de nombreuses commandes que leur passent la clientèle privée et les grandes sociétés.

Il y a lieu de citer encore les briqueteries mécaniques, les tuileries, les fabriques de carreaux et autres objets en ciment, et une usine de couleurs et vernis.

Plusieurs imprimeries très prospères sont alimentées surtout par les grandes administrations de la place.

Une importante fabrique de cigarettes traite des tabacs de production locale et d'importation.

Toutes ces activités ont pu se développer grâce à l'extension prise par la grosse industrie minière qui constitue la base de l'économie katangaise et lui imprime son rythme.

b) **Les firmes commerciales** : Elisabethville est un centre commercial actif et important. Les importateurs et exportateurs qui y sont installés desservent en fait tout le Katanga.

Le commerce Evillois de gros et de détail est alimenté par des importations directes. Les nombreuses Représentations et Agences assurent un approvisionnement constant et varié tant en matériel qu'en articles de consommation.

A côté des grossistes, de nombreux détaillants servent, les uns la clientèle européenne, les autres la population autochtone.

Ces magasins vendent des articles de luxe ou des objets de consommation courante. Ils sont fort bien achalandés et l'acheteur n'est souvent embarrassé que par la variété du choix. Une balance

commerciale favorable permet l'importation (sans restriction) d'articles made in U.S.A.

c) **Les entreprises agricoles :** les environs d'Elisabethville comptent une centaine d'exploitations agricoles dont l'activité se caractérise principalement par le « mixed farming », cultures fourragères, maraîchères et élevage du bétail laitier plus spécialement — en vue du ravitaillement de la population d'Elisabethville et de la main-d'œuvre de son centre industriel. La plupart des fermiers sont colons indépendants exploitant leur ferme à leur compte.

Les principales cultures consistent en cultures fourragères pour le bétail laitier, cultures maraîchères comprenant la plupart des légumes et, en quelques endroits, l'horticulture qui est florissante.

L'élevage est une des activités les plus étendues de nos fermiers. Le cheptel laitier ou beurrier s'élève à environ 3.000 vaches dans la zone d'Elisabethville. La porciculture compte 10 mille porcs dont 1.200 truies d'élevage.

Une laiterie dotée du matériel le plus moderne à l'initiative du Comité Spécial du Katanga (C.S.K.) à Elisabethville, fonctionne sous la forme de coopérative. Elle a pour but d'aider les colons à écouler leurs produits laitiers.

Elle a livré en 1953, entre autres, 580.000 litres de lait entier, 78 tonnes de beurre, 45 tonnes de fromage, 47.000 litres de yoghourt.

La Laiterie du Katanga assure la valorisation d'environ 70 % de la production laitière des fermes des environs d'Elisabethville et fut ainsi à la base du développement des entreprises agricoles de la région.

Actuellement, en considération de l'augmentation du coût de la main-d'œuvre indigène et de sa raréfaction, les fermiers s'efforcent de mécaniser progressivement leur exploitation; de même, l'augmentation du prix des farines et des tourteaux a amené les éleveurs à poursuivre leurs efforts en vue de développer la production et la conservation de fourrage et de foin.

Les fermiers ont recours pour le dessouchement, l'arasement de termitières et le premier labour au gros matériel du C.S.K., qui accorde, dans certains cas, des subsides pour améliorations foncières ou immobilières.

D'autre part, en matière d'élevage, le service vétérinaire du C.S.K. soigne gratuitement le bétail des colons, procède aux examens microscopiques, ainsi qu'aux analyses de lait, de crème et des solutions de « dipping-tank ».

Enfin, notons encore, à proximité d'Elisabethville, les Fermes et Stations Agricoles Expérimentales du Comité Spécial du Katanga, gérées par l'Institut National pour l'Etude Agronomique du Congo Belge (INEAC), dont les résultats des études et des essais sont au bénéfice des agriculteurs-éleveurs.



Danseur Baluba. Les Baluba sont une peuplade importante, installée au sud-est du Congo Belge.

Photo C. Lamote

VI. INFORMATIONS PRATIQUES.

1. — Agences de voyages, offices touristiques et bureaux d'informations.

a) à Elisabethville: *Agences de voyages.*

- Agence Maritime Internationale — A.M.I.
Building IMMOKAT — Téléphones 665 à 668 —
Adresse télégraphique: « AGENMARIN ».
- Voyages Dumoulin, Avenue de l'Etoile — Téléphone 800
Adresse télégraphique: « VOYAMOULIN »
- Voyages « IMMO » (Société Immobilière et Hypothécaire Africaine — IMMOAF)
Avenue du Kasai — Téléphone 260
Adresse télégraphique: « IMMOAF »

b) à Bruxelles: *Agences de voyages.*

- Agence Maritime Internationale — A.M.I., Cantersteen, 41,
(Siège Social: ANVERS, Rempart Sainte-Catherine, 61)
- Voyages Dumoulin, Bd. Adolphe Max, 77,
- Voyages « IMMO », rue de la Science, 5.

Bureau d'information.

- Centre d'Information et de Documentation du Congo Belge et du Ruanda-Urundi, Rue de la Putterie, 28 Bruxelles.

Office touristique.

- Office du Tourisme du Congo Belge et du Ruanda-Urundi,
Rue de la Putterie, 28

c) à l'Etranger: Offices touristiques.

— Office du Tourisme du Congo Belge et du Ruanda-Urundi
Bureaux à:

AMSTERDAM, Rokin, 106,

BERNE, Hirschengraben, 6,

BALE, Viadukstr., 60,

COPENHAGUE, Ostergade, 53,

JOHANNESBURG, 104, Corporation Bdgs,

Cor. Commissionner, — Rissik Sts.

LE CAIRE, Bd. Abbas-Heliopolis, 28,

LONDRES, Regent Street, W.1, 167,

LUXEMBOURG, Place de Paris,

NEW-YORK, Madison Avenue, 422,

OSLO, Kongensgate, 15,

NAIROBI, Overseas Touring Company, Salder Street,

P.O.Box 2196,

PARIS, 14, rue du 4 septembre,

QUEBEC, 3188, Chemin Ste Foy,

ROME, 76, Via Bissolati

2. — Formalités à remplir pour l'entrée au Congo Belge.

a) *Formalités administratives:*

Séjours de courte durée (tourisme, voyages d'affaires, etc...)

— *Pour les Belges résidant en Belgique:* se munir d'une « attestation de départ » — tenant lieu de passeport et de visa — délivrée par le Ministère des Colonies (rue du Pépin, 10, Bruxelles. Bureau 38, Service de l'Immigration). Il y a lieu de remettre à cet effet, au moins trois mois avant le départ, un certificat de bonne vie et mœurs (daté de moins de trois mois), deux photos, un questionnaire (à demander au Ministère des Colonies) et verser la caution d'immigration.

Si le séjour ne dépasse pas six mois le touriste est dispensé de ce versement à condition de produire une attestation de la Compagnie de Transport certifiant le paiement du voyage aller et retour.

Si, avant d'entrer à la Colonie, le voyageur traverse un territoire étranger (ex: l'Angola, les Rhodésies, etc...), l'attestation de départ sera remplacée par un passeport à faire viser, s'il y a lieu, pour les pays à traverser.

— *Pour les Belges résidant à l'Etranger*: faire viser leur passeport pour la Colonie par l'Autorité Consulaire Belge et, s'il y a lieu, pour la traversée des territoires étrangers. Verser la caution, si nécessaire.

— *Pour les Etrangers*: faire viser leur passeport par l'Autorité Consulaire Belge et se conformer à la réglementation sur le cautionnement.

Séjours de longue durée ou définitifs.

Se conformer aux prescriptions ci-dessus. Les colons désireux de s'établir au Congo Belge, doivent deux à trois mois à l'avance, solliciter l'accord d'entrée du Gouvernement Général de la Colonie par l'intermédiaire de l'Office de Colonisation (OFCO, 12 rue du Grand Cerf, Bruxelles).

Ces réglementations étant susceptibles de modifications, il est prudent de s'informer en temps voulu auprès des Agences de Voyages compétentes et, suivant les cas, auprès des organismes cités ci-dessus.

b) Formalités sanitaires:

Les voyageurs doivent produire AVANT le départ:

- un Certificat de vaccination anti-variolique, durée de validité: minimum 14 jours, maximum 3 ans
- un Certificat de vaccination contre la fièvre jaune, durée de validité: minimum 10 jours, maximum 6 ans (pour le passage par l'Egypte, le maximum est de 4 ans)
- un Certificat médical de bonne santé, datant de trois mois au plus, au moment de l'ENTRÉE au Congo. Sont dispensés de ce certificat, les Belges qui font un séjour de moins de 6 mois à la Colonie et les étrangers qui s'y rendent sous le couvert d'un visa de transit.

3. — Devises, changes, banques.

a) Introduction de devises:

DE BELGIQUE:

Les voyageurs qui se rendent dans la Colonie peuvent emporter 25.000 Fr. en devises belges ou congolaises.

Les transferts de fonds Belgique-Congo, couvrant les frais de voyage et de séjour peuvent s'élever à 100.000, — Fr. par voyageur, au départ.

Il est en outre permis de transférer 10.000,— Fr. par mois, pour entretien, de la Belgique au Congo.

Le colon qui s'établit au Congo peut y transférer des fonds sans limitations, en donnant toutefois justification.

DE L'ÉTRANGER:

Les réglementations de change étant fort différentes et variables, il est recommandé au voyageur de s'informer auprès des Banques et Agences de voyages compétentes.

b) *Cours de change*: le franc congolais est actuellement au pair avec le franc belge.

c) *Etablissements bancaires*:

1) *La Banque Centrale du Congo Belge et du Ruanda-Urundi.*

Agence à Elisabethville: Place Royale, 7, Tél. 990

Siège à Bruxelles: 54, rue de Namur, Tél. 12.16.33

Adresse télégraphique: « CENCORUBANK ».

Institut bancaire national. Banque d'émission et banquier du gouvernement du Congo Belge et du Ruanda-Urundi.

Effectue le contrôle des changes et le contrôle bancaire.

2) *La Banque du Congo Belge (B.C.B.)*

Agence à Elisabethville: Bâtiment « IMMOKAT »,

Tél. 633 à 639.

Siège à Bruxelles: 14-16, rue Thérésienne. Tél. 12.50.60

Adresse télégraphique: « CONGOBANK »

Banque privée.

3) *La Banque Belge d'Afrique (B.B.A.)*

Agence à Elisabethville: Avenue de l'Etoile, 67, Tél. 242

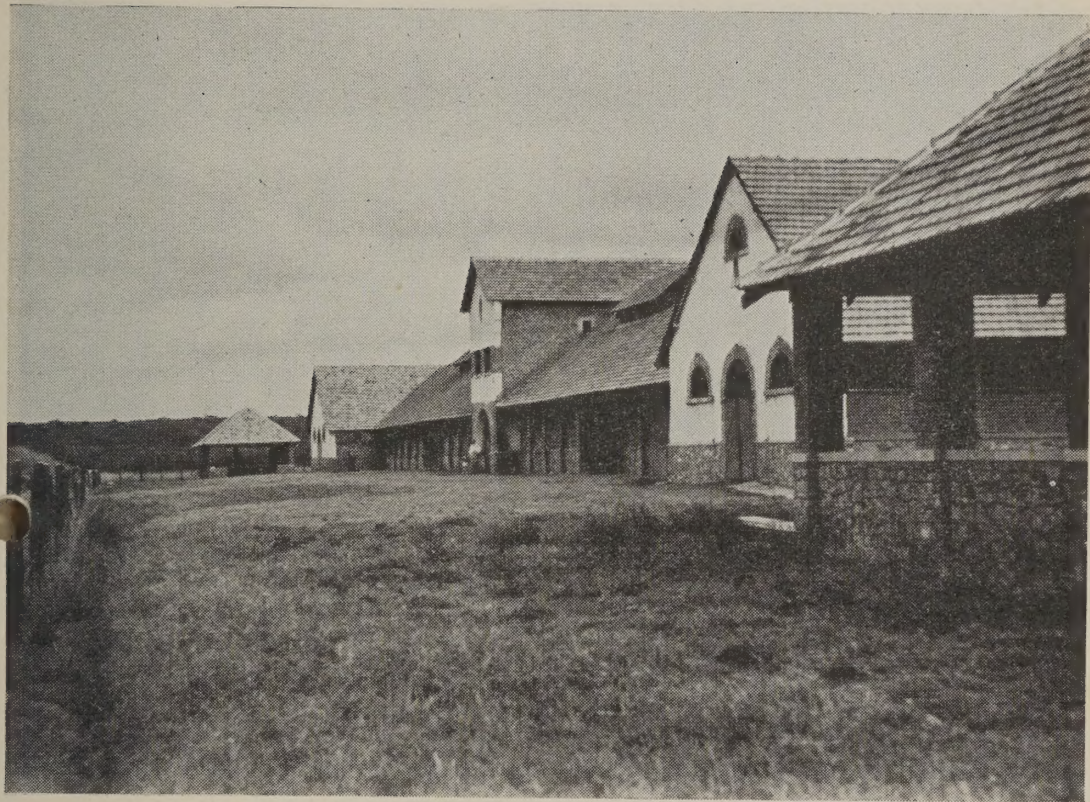
Siège à Bruxelles: 3, rue de Namur, Tél. 11.65.20

Adresse télégraphique: « AFRICABANK »

Banque privée.

4) *Société Congolaise de Banque (Socobanque)*

Agence à Elisabethville: Av. Lomami,



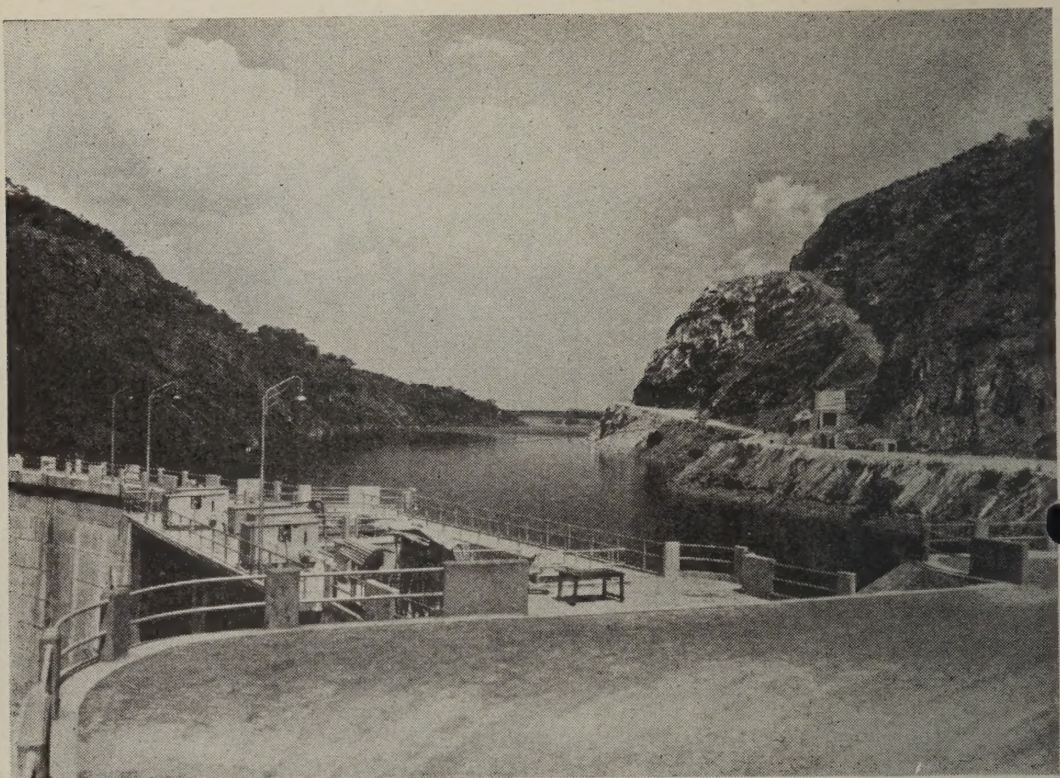
Elisabethville — Ferme Hubert Droogmans
Façade principale

Photo C. S. K.

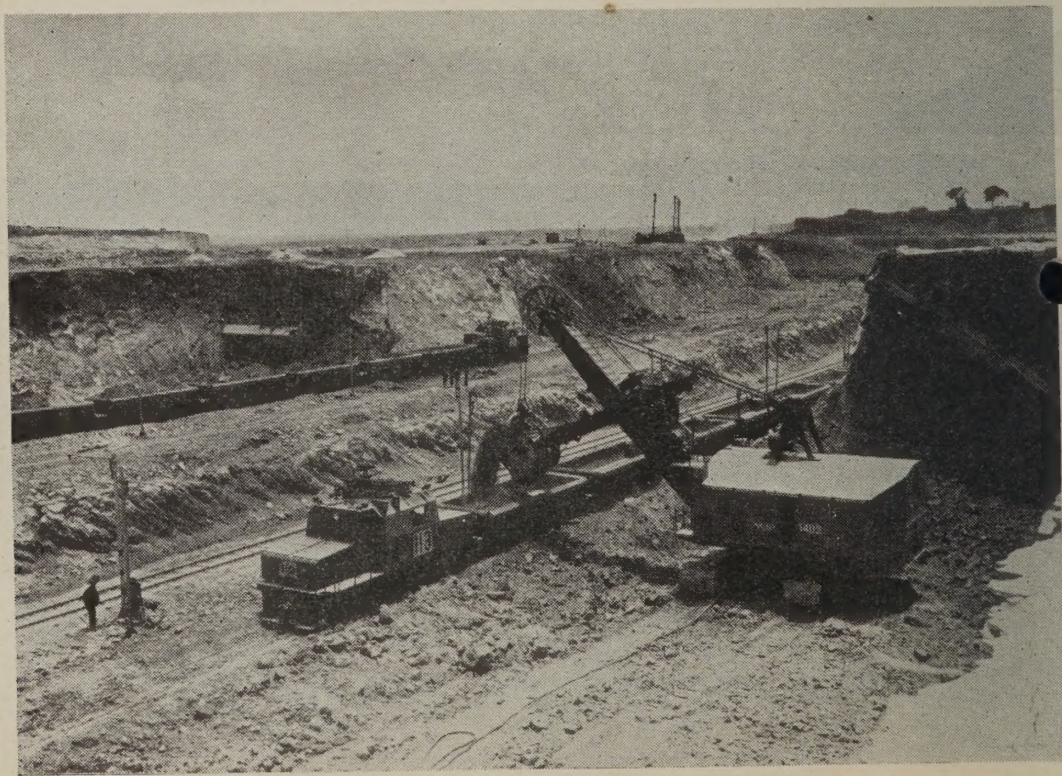


Troupeau laitier Friesland

Photo C. S. K.



Le barrage Delcommune, établi sur le Lualaba, aux gorges de N'Zilo
 La centrale électrique de ce barrage alimente en force électro-motrice les usines de
 l'Union Minière du Haut Katanga établies à Kolwezi, ainsi qu'une partie de ce
 territoire, important centre minier du Congo Belge Photo C. Lamote



Vue de la mine de cuivre de Musonoie,
 exploitée par l'Union Minière du Haut Katanga

Photo C. Lamote



Les grottes formées par la rivière Kilubi,
à une centaine de kilomètres au nord-est de Kamina

Photo C. Lamote



Le lac Tanganika à Albertville

Photo Lamote

ou du Carnet à l'entrée et à la sortie du territoire. Le conducteur devra être porteur d'un Permis International de Conduire et du Certificat International pour Automobiles.

Ces documents peuvent être obtenus auprès des associations touristiques et notamment le Royal Automobile Club du Katanga et le Touring Club du Congo Belge, tous deux représentés à Elisabethville.

d) Armes et munitions.

Il ne peut être importé au Congo Belge que trois armes au maximum par personne, c'est-à-dire:

- 1) 3 armes non rayées ou
- 2) 1 arme rayée et 2 armes non rayées ou
- 3) 2 armes rayées (dont une au moins sera un revolver ou un pistolet) et une arme non rayée.

Il ne peut en aucun cas être délivré de permis pour les armes tirant des cartouches de l'armement gouvernemental. Les porteurs d'armes devront présenter celles-ci au poinçonnage lors de leur entrée à la Colonie.

5. — Transports — Garages — Circulation automobile.

Elisabethville compte de nombreux garages dont liste au tableau ci-dessous. Le voyageur peut louer des taxis à la course et à la journée.

Garages

Noms	Adresse	Adresses télégraph.	Marques représentées	Tél. n°
Angeco	Av. Moëro	Angeco	—	115
Caviggia	Av. Sankuru	Caviggia	Fiat et Studebaker	435
Cégéac.	Av. Etoile	Cégéac	Groupe Ford	467
Central	Av. Moëro	Piesauto	Renault	377
Congo Motor	Av. Lomami	Motor	General Motor	255
Demoulin	Av. Kasai	Demoulin	—	320
Ets. Capelluto	Av. Royale	Capelluto	Groupe Chrysler	491
Ets. Econome	Av. Sankuru	Econome	Citroën-Nash	375
Prevers	Av. Leman, 1	Prevers	—	—
Sima	Av. Wangermée	Sima	Opel-Pontiac	504
Standard	Av. Etoile	Hoekman	Mercédès-Hudson	532
Verfaille	Av. Droogmans	Verfaille	Volkswagen	832
Antoniadis	Av. Lomami	Antoniadis	Auto-Union	566
			Diamond	
Duncan Smith and Co	Av. Kasai		Packard	605/
			Groupe Rootes	1077

L'essence revient à 5,60 fr. le litre (au 1.9.54)

Permis de conduire.

Tout conducteur de véhicule automoteur doit être muni d'un permis de conduire, délivré par le Bureau de Police, après examen pratique et théorique. Ce document peut être remplacé par le permis international de conduire (validité 1 an — délivré par les Automobiles Clubs et Touring Clubs)

Circulation.

Les véhicules doivent tenir la droite, mais dépasser à gauche. Aux bifurcations, le conducteur de véhicule est tenu de céder le passage au conducteur qui débouche à sa droite (Priorité de droite).

L'attention des voyageurs est attirée sur les signaux « STOP », aux carrefours, ainsi que sur certaines voies importantes jouissant de la priorité et qui sont signalisées.

6. — Hôtels et restaurants.

a) *Tarif moyen des hôtels et restaurants de bon standing:*

<i>Logement</i>		<i>Repas</i>	
Appartement	Fr. 400,—	Petit déjeuner	Fr. 30,—
Chambre av. salle bain	275,—	Déjeuner	80,—
Chambre sans bain	150,—	Dîner	85,—

b) *Liste des hôtels et restaurants d'Elisabethville:*

1) *Hôtels-Restaurants:*

Outre le	Apparte- ments avec salle de bain privée	Chambres av. salle de bain privée	Chambres sans s.d.b. privée, mais av. s. d. b. commune	
GUEST HOUSE SABENA (près de l'aérodrome) et le GRAND HOTEL LÉOPOLD II (Av. du Kasai)	20 2 —	18 58 20	— — 16	 av. tél. privé

Elisabethville comprend égale- ment les hôtels suivants (en ordre alphabétique)	Apparte- ments avec salle de bain privée	Chambres av. salle de bain privée	Chambres sans s.d.b. privée, mais av. s. d. b. commune	
— Albert Ier (Av. Royale)	1	6	26	
— Ambassador (Av. Royale 38)	5	—	4	
— Belle-Vue (coin Av. Royale et du Kasai)	—	—	28	
— de Bruxelles (Av. de l'Etoile)	—	—	24	
— Central (Av. du Lomami, 18-20)	1	—	10	
— Cosmopolite (Av. du Lomami 16)	—	—	16	
— Grand Hôtel (coin Av. de Saïo et Av. de l'Etoile)	—	—	22	
— du Katanga (Av. Wangermée)	—	—	8	
— Le Lido (près de la Lubumbashi)	—	2	9	bassin de natation
— Pekstarts (Av. Lomami)	1	—	6	
— Terminus (Av. des Usines 71-73)	—	—	9	
— de l'Yser (Av. Lomami, 36)	—	—	12	
2) Hôtels sans restaurant (en ordre alphabétique)				
— Cecil (Av. Maniéma, 8)	1	—	8	
— Demol (Av. Wangermée, 59)	—	—	4	
— Leman (Av. Leman, 48)	—	—	3	
— Macris (Av. Moëro 86)	—	—	12	
— Guest-House Wangermée (Av. Wangermée, 77)	—	5	4	

3) Restaurants (en ordre alphabétique)

Aéro-Bar (près de l'aérodrome)
Le Ranch (Av. Stanley)
Restaurant « Le Royal » (Av. Royale)
Taverne du Palace (Place Albert)

7. — Services religieux.

A. Religion catholique romaine:

Cathédrale des SS. Pierre et Paul, Avenue Leman:
Chapelle Mater Dei (Institut Marie-José), Avenue du Lomami.
Collège St. François de Sales, Avenue Wangermée.
Saint-Eloi, Lubumbashi.

B. Garenganze *Evangelical Mission*; 137, Route de l'Etoile.

C. Mission Méthodiste, Avenue Limite Sud.

D. Synagogue: coin Avenue Churchill et Avenue de Saïo.

E. Orthodoxe: Avenue Moëro.

8. — Postes — Télégraphes — Téléphone.

Le bureau de la Place Albert Ier (au centre de la ville) abrite les services de la Poste, des Téléphones, des Télégraphes et de l'Office des Chèques Postaux.

Postes.

Les lettres et cartes postales sont transportées par avion à l'intérieur de la Colonie, sans surtaxe, lorsque l'utilisation de cette voie en accélère l'acheminement.

Les service des mandats-poste fonctionne avec tous les pays, sauf les mandats télégraphiques qui ne peuvent être utilisés qu'avec la Belgique.

Télégraphes.

Le bureau télégraphique est ouvert au public, en semaine, de 8 à 12 h. et de 14 à 17 h. (sauf le samedi). Le dimanche de 8 h. 30 à 9 h. 30.

Téléphones.

Elisabethville a son propre réseau téléphonique fonctionnant jour et nuit et qui est relié, d'autre part, aux réseaux ci-dessous :
au Congo Belge: Jadotville, Léopoldville et Bas-Congo, Luluabourg, Stanleyville.

en Afrique: Brazzaville (A.E.F.), Mozambique, Réseaux de la Rhodésie du Nord et de la Rhodésie du Sud, Union de l'Afrique du Sud.

En Europe: Belgique et autres pays d'Europe.

9. — Presse.

Deux journaux quotidiens:

L'Echo du Katanga

L'Essor du Congo

Trois hebdomadaires:

Le Mercure Africain

Congo-Soir

Standpunten

Un journal congolais d'information hebdomadaire:

Le Progrès

Un journal bi-mensuel pour congolais:

L'Etoile-Nyota.

10. — Représentation consulaire.

Consulats: Danemark	Av. du Lomami
Etats-Unis	Bd. Elisabeth
France	Av. Albert
Grande-Bretagne	Bd. Elisabeth
Grèce	Place Albert (bât. Crédit Foncier)
Italie	Av. Ruwe
Liban	Bd. Elisabeth
Union Sud-Afric.	Av. du Sankuru (bât. Caviggia).
Pays-Bas	à Jadotville
Portugal	Léopoldville.
Suisse	Léopoldville.

11. — Associations touristiques.

Les principales associations touristiques d'Elisabethville sont

- le Royal Automobile Club du Katanga (Av. de l'Etoile, 111) et le Touring Club du Congo Belge (bâtiment « IMMOKAT »), qui sont toujours heureux de pouvoir aider et renseigner les voyageurs et se tiennent à leur entière disposition pour faciliter leur séjour et leurs démarches.

12. — Associations et Groupements divers.

Elisabethville comprend de nombreuses associations sportives permettant ainsi la pratique de la majorité des sports. Il y a notamment un Aéro-Club, un Club de Golf, un Cercle Hippique, des Cercles de Tennis, de football, un Bowling Green, de Basket-Ball, etc...

Divers groupements artistiques, culturels, patriotiques, se partagent les faveurs de la population.

13. — Distractions — Spectacles — Sports.

Consultez les journaux: la rubrique « Où aller aujourd'hui », de l'Essor du Congo, et les communiqués de l'Echo du Katanga.

Ecoutez les postes de radiodiffusion d'Elisabethville:

Radio Collège:	chaque jour de 18 h. 30 à 19 h. 30 longueurs d'onde 80-60 et 41 mètres
Radio Elisabethville	le dimanche de 15 h. 30 à 18 h. longueur d'onde de 25 et 41 mètres
Radio Ufac	chaque jour de 19 h. 30 à 22 h. le dimanche de 12 h. 30 à 15 h. longueur d'onde de 41 mètres

Visitez La cité indigène, le Musée Léopold II (Bd. Elisabeth). etc....

Allez au cinéma: Coliseum, Avenue du Sankuru,
Palace, Avenue du Sankuru,
Studio R.A.C., Avenue du Maniéma

au Lido	sur la Lubumbashi
au Miami	route Dom Bosco
au Ranch	Av. Stanley
au Relais	route de Jadotville

On nage: au Lido et au Miami.

L'U.A.A.L. et les Cercles d'Elisabethville vous invitent à leurs spectacles, concerts et conférences.

Les Cercles sportifs vous souhaitent la bienvenue à leurs compétitions, qui se déroulent sur leurs terrains, au Stade de la Victoire et au Stade Léopod II.

Le golf, le tennis, l'équitation, le bowling green, la chasse où un petit et gros gibier vous attendent.

14. — Secours.

Commissariat de police — permanence: Tél. 145, Av. Tabora

Eau — Regideso: Tél. 475, Av. Moëro

Electricité — Sogelec: Tél. 161, Av. Royale

Médecins:

Hôpital pour Européens, Tél. 213, Av. Tanganika

Hôpital pour Indigènes, Tél. 135, Av. du Sankuru

La liste des médecins de garde est publiée chaque samedi dans les journaux.

Pharmaciens:

Cophaco, Place Albert Ier Tél. 551

Matsoukis, Av. de l'Etoile Tél. 600

Socophar, Place Albert Ier Tél. 770

Unicongo, Av. du Sankuru Tél. 182

Le tableau du « pharmacien de garde » est affiché à l'entrée de chaque pharmacie.



Les chutes de la rivière Kilubi,
à une centaine de kilomètres au nord-est de Kamina

Photo C. Lamote



Le « njimba » instrument de musique au son mélodieux, employé par les Balunda,
installés entre les rivières Kasai et Lualaba, au sud du Congo Belge

Photo C. Lamote



ELISABETHVILLE
Le palais du Cinquantenaire

Photo Rager Pérée

VIII. — LE TOURISME DANS LA PROVINCE DU KATANGA

Par son altitude, ses hauts plateaux d'où sortent le fleuve Congo et quelques-uns de ses affluents, ses plaines giboyeuses et son climat tempéré, le Katanga exerce un grand attrait touristique. Cette Province du Congo Belge, essentiellement industrielle, où les méthodes les plus modernes d'exploitation sont employées et où l'effort accompli dans le domaine social est remarquable, compte également de nombreux sites très pittoresques.

Elisabethville.

Du chef-lieu provincial, Elisabethville, partent vers les environs immédiats une dizaine de circuits agréables pour automobilistes. Ces promenades, de 30 à 90 km., sont toutes signalisées par des plaques indicatrices. (x) Citons entre autres le circuit de la Munama, avec ses paysages européens aux abords des stations d'élevage et agricole de Keyberg, le point de vue majestueux du Mont Mukwene dont l'ascension est conseillée. Nombreuses sont encore les promenades attachantes, autour de la ville, parmi les vertes vallées ou « dembos », les élevages et les sous-bois reposants et typiquement katangais, telle la promenade de Nyamumenda et celle de Lukuni plus sauvage.

L'industrie minière et ses activités accessoires constituent également, dans les environs d'Elisabethville, une certaine attrac-

(x) Le guide routier des environs d'Elisabethville peut être obtenu au local permanent du royal Automobile Club du Katanga (T. 800).

tion touristique. Citons l'importante usine de Lubumbashi avec son immense terril et sa cheminée la plus élevée du continent africain, la mine souterraine Prince Léopold à Kipushi. (x)

Les centres touristiques naturels du Katanga.

Nous donnons ci-après la liste des sites qui méritent d'être visités. Toutefois beaucoup de beautés naturelles ne se trouvent pas sur la ligne des itinéraires routiers et, pour les approcher, il faut souvent emprunter, sur une distance de quelques centaines de mètres, des sentiers peu fréquentés à travers la brousse et escalader parfois des collines abruptes.

Il s'agira souvent d'une petite excursion de quelques kilomètres à entreprendre au départ de l'hôtel ou du gîte d'étape. Les automobilistes devront se procurer une bonne carte, il leur sera nécessaire de bien repérer tous les croisements, d'avoir toujours à bord une réserve d'essence et de faire le plein à toute occasion.

En ce qui concerne les hôtels, constatons qu'en dehors d'Elisabethville et de quelques localités comme Jadotville, Kolwezi, Manono, Kabalo et Kongolo, le voyageur ne trouvera généralement qu'une auberge de capacité restreinte et sans le confort auquel les étrangers sont habitués, tels lumière, eau courante, voire salle de bain. Par contre la table est de bonne qualité. Il faut donc se résigner à faire la part des choses. Le pittoresque et l'attrait de la plupart des sites grandioses de cette partie du Congo Belge en font avec son climat, malgré l'absence parfois de confort, une des régions les plus attachantes de l'Afrique.



(x) La visite des installations industrielles et minières est interdite. Pour solliciter l'autorisation, il y a lieu de s'adresser à la Direction des Sociétés.

LISTE DES SITES LES PLUS REMARQUABLES A VISITER AU KATANGA

Région du Katanga Méridional.

1. — Chutes Johnson (sur rivière Luapula à 29 km. en amont de Kasenga).
2. — Chutes Giraud (sur rivière Luapula à 25 km du poste de Kabunda, Territoire de Sakania).
3. — *Chutes de la Lofoi (gite d'étape).*
4. — *Chutes de Kiubo (hôtel)*
5. — Falaises déchiquetées des Kundelungu
6. — *Plateau des Kundelungu (gite d'étape)*
7. — Confluent du Luapula et de la Kafubu (Kiniamo) (Logement).
8. — Ancien village de Bunkeya (ex-capitale de M'Siri, roi du Katanga).
9. — Barrage de N'Zilo, gorges et rapides (25 km. de Kolwezi)
10. — *Point de vue de Shituru (Jadotville) et table d'orientation*
11. — Chutes de la Kalule près de Lubudi.
12. — Barrage de Mwadingusha (chutes Cornet) (80 km. de Jadotville).

Région du Katanga Central.

13. — Grottes et chutes de la Kilubi (Kifita et Pitanshi).

Katanga du Nord.

14. — Chutes de la Kalumengengo et de la Panda au Nord de Mitwaba (sur la route entre Mitwaba et Manono, escarpement de Manono) Hôtel.

15. — Embouchure de la Luvua et le point de vue de Pweto sur le lac Moëro.

16. — Portes d'enfer à Kongolo et sources thermales.

17. — Lacs Kabale près de Mani (au Nord de la ligne Kamina-Kabinda).

18. — Chutes de la Lubangule près de Mani.

19. — Camp Jacques à Albertville (historique).

Nous ne décrivons que les sites principaux ci-dessus avec les possibilités d'accès. Pour les autres endroits il convient de s'informer des communications auprès du Syndicat d'Initiative Touristique pour la Province du Katanga (Place Royale c/o District le Touring Club du Congo Belge (bâtiment « IMMOKAT ») ou le Royal Automobile Club du Katanga (av. de l'Etoile, 111) B.P. 998 — Tél. 800 — Elisabethville.

A. — Chute de la Lofoi.

Le site charmant de la chute et du cours de la Lofoi a toujours retenu l'attention du touriste. A 220 km. d'Elisabethville, sur la route Minga-Sampwe, une piste quitte la route au village de Kongo vers le gîte d'étape.

La rivière coule sous le gîte dans un site délicieux. L'excursion vers la chute demande deux heures de marche dans chaque sens. Cette expédition très agréable nécessite toutefois deux journées au départ d'Elisabethville.

La chute de la Lofoi tombe à pic d'une hauteur de 340m., elle est la plus haute chute verticale du continent africain.

B. — Chutes de Kiubo et Bunkeya.

Plus au Nord, en continuant la route de Minga-Sampwe, la rivière Lufira présente une longue succession de rapides se terminant par des chutes. Celles de Kiubo, de 60 m. de hauteur sur 250 m. de large, aux environs de Sampwe, sont d'un pittoresque remarquable. Kiubo dispose d'un hôtel. Le coucher de soleil sur les chutes est de toute beauté.

De la route Minga-Sampwe on longe à droite les falaises déchiquetées des Kundelungu.

Le retour peut se faire par Bunkeya, l'ancienne capitale du royaume du Katanga du potentat noir M'Siri où se joua, en 1891, le drame qui coûta la vie au Capitaine Bodson et à M'Siri. De là on rejoint Jadotville distante de 75 km.

C. — *Plateau des Kundelungu.*

L'accès des immenses et grandioses plateaux des Kundelungu d'une altitude de 1.600 à 1.800 m. est possible en voiture, en empruntant la route de Kasenga jusqu'au village de Shangongo, à une centaine de kilomètres d'Elisabethville. A Shangongo on bifurque à gauche vers les plateaux. Ceux-ci sont non seulement grandioses mais intéressants pour leur faune très variée en antilopes, lions, guépards, etc... (203 km). On peut loger au gîte d'étape de l'Automobile Club (s'adresser 111 Av. de l'Etoile).

D. — *Barrage de Mwadingusha (Chutes Cornet) et barrage de Koni.*

D'Elisabethville on se dirige vers Sofumwango, sur la route de Jadotville; de là on se rend à Mwadingusha (chutes Cornet), à 80 Km. de Jadotville, où la masse des eaux de la rivière Lufira s'abat brusquement d'une centaine de mètres pour être captée et utilisée dans les usines de la Sogefor. A 13 Km., visite du barrage de Koni (l'autorisation préalable de l'Union Minière est requise). On revient par les salines de Mwashia (gîte), Kienge, la Lofoi et Minga-Elisabethville.

E. — *Point de vue de Shituru (Jadotville) et table d'orientation.*

L'observatoire et la table d'orientation au sommet de la colline de Shituru, d'où l'on jouit d'une vue panoramique splendide sur les usines de la région.

F. — *Chutes de la Kilubi.*

Dans la région de Kamina, au nord-ouest du Katanga. En sortant de Kamina par la bonne route de Bukama, prendre au Km. 12 la route de Kabongo qui traverse l'immense plateau du Lomami. Après 91 Km. on rencontre sur la droite une piste de 45 Km., créée par le Touring Club et qui rejoint la grand'route plus



Les bureaux du Comité Spécial du Katanga à Elisabethville.

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PLAN DE LA VILLE D'ELISABETHVILLE





DES PRESSES IMBELCO - ELISABETHVILLE

INSTITUT NATIONAL
POUR L'ETUDE AGRONOMIQUE
DU CONGO BELGE.

====:=====

FIFTH INTERNATIONAL CONGRESS
OF SOIL SCIENCE.

Excursion III at Elisabethville.

EXCURSION GUIDE.

EXCURSION I

Aim : The aim of this excursion is to give a general idea , on the geological constitution of the area, in relation ship to the geomorphology and the soils.

Itinerary : Departure from Elisabethville on thursday september 2d at 1.30 p.m. in the direction of Kipushi, to beyond the first anticlinal of Kisanga.

1. Gravelly soil without lateritic crust, developped on the Upper Pléistocène gravels, lying at about 1 m. on the red spotted shales.
2. Red latosol on the Kakontwe limestone under open forest.
(Kipushi series)

The Kipushi soils are deep, well drained, clayey, dark red latosols derived principally from the Kakontwe limestone.

The soils occur characteristically in large well drained gently sloping depressions.

The gravel layer appears almost under the red clay at a depth ranging from 3 to 4 m.

Soil profile :

- SH₁ Dark reddish brown (2.5 YR 3/2) sandy clay.
Fine granular structure.
Friable. Very dense roots bind the materials formed of well mixed organic matter, some charcoal and ashes from fires
(± 4 cm.)
- SH₂ Dark red (2.5. YR 3/6) to reddish brown (2.5 YR 4/4) clay. Infiltration of organic matter.
Medium, well developed, subangular blocky structure
Firm, somewhat compact in place, breaks down easily into fine granular units when removed.
Moderate amount of roots in upper part decreasing rapidly in lower part. (from 4 to 70 cm.)
- SNH Red (10 R 4/6) clay.
Medium subangular blocky; moderately firm in place, very friable when removed. (+ 70 cm.)

Some analytical data are represented in table II.

3. Red latosol on dolomitic rocks in the anticlinal (Kasonta series).

The Kasonta soils are deep well drained, sandy-clayey, red to dark red latosols deriving principally from eolian deposits originating from dolomitic rocks, with more or less admixture of material originating from dolomitic-shales. The gravel layer appears almost at a depth ranging from 2 to 4 m.

Soil profile.

- SH₁ Humic, reddish brown (2.5 YR 4/4) sandy clay.
Fine well developed granular structure. (5 cm.)
- SH₂ Dusky red (10 R 3/4) to dark red (2.5 YR 4/6 sandy) clay. Infiltration of organic matter.
Well developed coarse to medium subangular blocky structure.

Very firm, somewhat compacted in place especially
When dry, moderately friable when removed; roots decrease
rapidly in size but are uniformly distributed. (5 - 70 cm.)

SNH Dark red (2.5 YR 3/6) sandy clay.
Weakly developed medium angular blocky structure.
Loose (farinuous) consistence.

Some analytical data are represented in table III.

4. Kisanga hill : (escarpment hill soils).

Section with a sight on the stratigraphy of the shales and
sandstones of the Mwashya serie.

5. Yellowish red latosol on "Grand Conglomérat". (Misowa series)

The Misowa series include well-drained, sandy clayey, yellowish red latosols, deriving from deposits originating from "Grand Conglomérat" with admixtures or sandstone material originating from the Mwashya sandstone.

The gravel layer invariably appears in the substratum at depths ranging from 10 to 60 cm. for the shallow soils, from 60 - 100 cm. for the intermediate soils and deeper than 100 cm. for the deep soils. Under the gravel layer appears the red spotted shale.

Soil profile :

SH_I Dark greyish brown (10 YR 4/2) clayey sand.
Fine granular structure. ($\pm$ 5 cm.)

SH₂ Yellowish red (5 YR 5/6) clayey sand.
Medium well developed blocky structure.
Firm, somewhat compact in place. (from 5 to 50 cm.)

HG Gravel layer (from 50 to 120 cm.)

SRB Red spotted shale, product of weathering from the
underlying bedrock.

Some analytical data are represented in table IV.

Beyond the village of Keyberg, we can see on the right hand a rock-outcrop characterised by a zonal shale, between the Kakontwe limestone and the "Grand conglomérat".

6. Rock outcrop of the Kakontwe limestone in the Kimilolo valley.

We also can observe a section through a red latosol, on the border of the valley. In the deeper layers we can see the weathering products of the limestone.

7. Pré-Gamblien laterite:

Profile : -- Laterite crust.
-- red spotted shale with gley.

8. Yellowish red latosol on the Lubumbashi limeshales:

The Kaponda soils are deep well drained clayey yellowish red to light red latosols derived principally from deposits on the limeshales and macignos of the Kundelungu system.

The soils occur in catenary association with the well drained yellowish brown Musaonga soils, the moderately well drained Kasapa soils, the imperfectly drained Kampemba soils, the poorly drained Mutwale soils and the

very poorly drained Lubumbashi soils.

The gravel layer appears almost at a depth ranging from 1 to 2 M. Under gently sloping topography the gravel layer may be thick (50 cm.) on the moderately steep topography, ranging towards the river valleys the gravel layer is present as a stone line (Hill wash gravels).

- Profile :
- Horizon with superficial deposits - 1,5 m. thick.
 - Gravel layer (stone line)
 - Red spotted shale, product of weathering of the Lubumbashi shale.

Some analytical data from a similar soil profile :

Fraction. mechanical analyse	% of each fraction for :	
	Superficial deposits	Red spotted shale
0 - 2	35,7	30,8
2 - 20	26,2	33,3
20 - 50	27,2	24,2
50 - 100	5,5	4,4
100 - 250	1,6	1,3
250 - 500	0,5	0,5
500 - 1000	0,8	0,6
1000 - 2000	2,5	4,9

Minerals :

- Inalterable	97 %	81 %
-Potassiques	1 %	0 %
- Calco-sodiques	6 %	19 %

EXCURSION II.

- September 2 : 22 hrs. Departure by railway to Jadotville. Accomodation on the train.
- September 3 : 6 hrs 30. Breakfast in Dining Coach (two services)
- 7 hrs 15. Arrival at Jadotville
- 8 hrs. Visit of the social works and the hospital of the U.M.H.K.
- 10 hrs. Visit of the copper electrolyse factory at Shituru.
- 11 hrs 30. Visit of the mineralogical museum Sengier - Cousin.
- 12 hrs 30. Lunch at the " mess U.M.H.K."
- 14 hrs 30. Visit of the central workshop of the U.M.H.K.
- 16 hrs. Refreshments at hotel.
- 17 hrs 45 Start by railway for Elisabethville.
Dinner in Dining Coach.
- 21 hrs 15 Arrival at Elisabethville.

EXCURSION III

AIM : - Study of the erosion classes - effect of the fires on the degradation of the top soils.

- Study of a very poorly drained swamp soil on calcareous sediment.
- Study of the catenary sequence in the dolomitic soils.

I. Yellowish red latosol (Kaponda series) under forest.

The soil has a continuous A horizon and had not suffered from erosion.

Soil profile:

L	0 - 8 cm.	Clay mull - organic matter decomposed.
SH ₁	8 - 15 cm.	Very humic reddish brown (5 YR 4/4) clay. Medium well developed granular structure.
SH ₂	15 - 24 cm.	Humic reddish - brown (5 YR 4/4) clay. Coarse, well developed structure.
SH ₃	24 - 34 cm.	Reddish-brown (2,5 YR 4/4) clay transition.
SH ₄	34 - 50 cm.	Red to reddish-brown (2,5 YR 5/6 à 4/4) clay. Medium well developed blocky structure. Firm, somewhat compact
SNH	50 cm +	Red (2,5 YR 5/4) clay. Coarse poorly developed blocky structure. Loose consistence.

Some analytical data are represented in table V.

2. Yellowish red latosol (Kaponda series) under degraded savana vegetation.
(The profile is situated at 30 m from the first profile)

The profile presents a degraded top soil as evidenced by a humocky surface, much erosion having taken place between grass clumps.

Soil profile :

SH ₁	0 - 1 cm.	Dark reddish brown (5 YR 3/2) clay. Medium well developed granular structure.
SH ₂	1 - 10 cm.	Dark reddish clay (5YR 4/2) clay. Somewhat infiltration of organic matter. Medium, well developed blocky structure. Firm in place.
SH ₃	10 - 50 cm.	Yellowish red (5 YR 5/6) clay. Coarse well developed blocky structure. Firm, and somewhat compact.
SNH	50 cm. +	Red to yellowish red (5 YR 4/8 to 2.5 YR 5/8) clay.

Some analytical data are represented in table V.

3. Very poorly drained swamp soil on calcareous sediment in the Kisanga valley at Keyberg. (Kisanga series)

This very poorly drained half-bog soil developed on calcareous alluvial deposits derived from the Kakontwe limestone.

The Kisanga soils occupy permanently wet lowlands on the edges of sluggish streams bordered by marsh land.

Soil profile :

- 0 - 35 cm. Muck. Partially decomposed weeds and grasses (Typha)
35 - 48 cm. Dark grayish brown (2.5 Y 4/2) humic, calcareous clay.
48 - 130 cm. White (2.5 Y 8/2) calcareous sediment.
130 - 175 cm. Peat.

The CaCO_3 content of the upper organic layer is about 33 %, the calcareous sediment contains 75 to 83 % CaCO_3 and the underlaying peat still 14 % CaCO_3 .

The pH varies as follow : Muck : 7,7
Calcareous sediment : 8,5
Underlaying peat : 7,5

At 12 hrs. lunch at the Golf club at Elisabethville.

4. Calciumcarbonate concretions in the heart of a anthill just above a lateritic crust.
5. Study of a catenary soil sequence in the dolomitic area :

5.1 - Red latosol on dolomitic rocks (Lupoto series)

The Lupoto soils are deep well drained clayey red to dark red latosols deriving from wind deposits originating principally from dolomitic shales. The motling layer is deeper than 10 m.

Soil profile :

- SH₁ Very dusky red (2.5 YR 2/2) humic sandy clay.
Fine, well developed granular structure. (3 cm.)
SH₂ Clay with infiltration of organic matter.
The color is dark reddish brown (2.5 YR 3/4) in the upper part of these layer and range to dark red (10 R 3/6 to 4/6) in the lower part of the horizon.
Coarse, well developed blocky structure.
Firm, somewhat compact, in dry season. (3 to 70 cm.)
SNH Red to dark red clay (10 R 3/6)
Loose consistence.

5.2. - Yellow latosol on dolomitic rocks : (Kasombo series)

The Kasombo soils are yellowish red sandy clayey to clayey soils, derived from deposits originating principally from dolomitic rocks. The motling layer may appear at about 5 to 10 m.

Soil profile :

- SH₁ Dark brown (7.5 YR 3/2) sandy clay. (4 cm.)
SH₂ Brown to dark brown (7.5 YR 4/4) sandy clay.
Infiltration of organic matter.

In the lower part of these layer the color range to yellowish red (5 YR 4/6)

Coarse, well developed, blocky structure. (4 - 60 cm.)

SNH Yellow to yellowish red (5 YR 5/8 to 7.5 YR 5/6)
clay.
Very loose consistence. (60 cm. +)

5.3 Hydro-latosol on dolomitic rocks : (Mwita series)

The Mwita soils are deep, moderately well to poorly drained sandy clayey to clayey soils derived from deposits originating from dolomitic rocks. The soils occur in more or less narrow bands around lowlands between the well drained latosols and the poorly drained gray hydromorphic soils, forming a catenary sequence.

Soil profile :

SH₁ Brownish gray (10 YR 5/2) clayey sand.
Humic. Fine well developed granular structure.
Loose consistence. (4 cm.)

SH₂ Light yellowish brown (10 YR 6/4) ranging to yellowish brown (10 YR 5/6) in the lower part of these layer, sandy clay.
Medium, well developed blocky structure.
Firm. (from 4 to 60-70 cm.)

SNH Pale yellow (2.5 Y 7/4) clay, with coarse sand grains scattered throughout the clayey matrix. Motled with red.
Medium to coarse angular blocky structure. The structural units have little cohesion.
Firm in place, loose when removed.

5.4. Gray hydromorphic soil on dolomitic rocks : (Mutwale series)

The Mutwale series include intrazonal, poorly drained soils of latosol regions developed on recent colluvium and Swamp deposits. The soils occur in a catenary association with the well-drained, latosols, the moderately well and imperfectly drained hydro-latosols. They are found in lowland, determined by old filled valleys, adjacent to the plateau soils. (Dembo soils).

Soil profile :

SH₁ Black to very dark gray (5 YR 2/2 to 2.5 Y 3/0)
sandy clay. Humic.
Granular crumb mull with very dense roots.
Loose and friable. (2 cm.)

SH₂ Olive gray (2.5 Y 5/2) sandy clay.
Some infiltration of organic matter.
Well developed medium subangular blocky structure. (2-30 cm.)

SNH Light gray (2.5 Y 7/2) clay. (+ 30 cm.) with motling.

Some analytical data of these four profiles are represented in table VI.

EXCURSION IV - (facultative)

September 5.

Aim : Study of a soil catena in the area of "Grand conglomerat" and sandstones of the Mwashya series.

I. Yellowish red latosol : Misowa series)

The Misowa series include well-drained, sandy clayey, yellowish red latosols, deriving from deposits originating from "Grand Conglomerat" with admixtures of sandstone material originating from the Mwashya sandstone. The soils occur in a catena association with the well drained yellow Luano soils, the moderately well drained Fipango soils, and the poorly drained Kamalenga soils.

Soil profile : (deep soil)

SH ₁	Humic, dark reddish brown (5 YR 3/2) clayey sand. (3 cm.)
SH ₂	Reddish brown (5 YR 4/3) clayey sand. Infiltration of organic matter. Becomes yellowish red (5 YR 4/8) in the lower part of these horizon. Coarse well developed subangular blocky structure. Somewhat compact in place.
SNH	Yellowish red (5 YR 5/8) clayey sand. Very loose consistence.

2. Yellow latosol in the same parentmaterial : Luano series).

The Luano series include well-drained, sandy clayey, yellow latosols, deriving from the same parentmaterials as the Misowa series. Motling appears at about 2 meters.

Soil profile :

SH ₁	Humic, very dark grayish brown (10 YR 3/2) clayey sand. Fine granular structure. (8 cm.)
SH ₂	Dark grayish brown (-10 YR 4/2) clayey sand. Infiltration of organic matter. Medium, well developed blacky structure.
SNH	Yellowish brown (7.5 YR 5/6) clayey sand. Loose consistence.

3. Hydro-latosol in the same parentmaterial :(Fipango series)

In the catena of these sandy soils the Fipango series occurs as the moderately well drained unit :

We can observe a section in these soils with transition to the poorly drained Kamalenga soils.

Section :

- 0 - 2 m. Clayey sand motled with red.
- 2 - 2,5 m. Gravel layer, with red concretions, and stone age implements. (Muhilien)

The analytical data of these three profiles are represented in table VII.

TABLEAU I.

Explanation of the reconnaissance map.

R. SOILS DERIVED FROM PALEOZOIC ROCKS :

R. Lithogénic soils and rock outcrops.

g. Soils derived from the gravel layer.

g₁ Gravels on laterite crust, ranging in the deeper layers to the red spotted shale. (Katuba series).

g₂ Gravels without laterite crust (Kisangwe series)

g₃ Gravels in sandy material, in the area of "Grand Conglomérat" often presense of laterite.

s. Well drained latosols, derived from deposits originating from the different geological formations.

sGS - Yellow admixed with some yellowish red clayey soils in the area of the synclinal (Association Musaonga - Kaponda)

sGS_I- Yellowish red clayey soils in the area of the synclinal (Kaponda series)

sGS₂- Yellow clayey soils in the area of the synclinal.(Musaonga series.

sCK_I- Red soils in the area of the Kakontwe limestone.(-Kipushi series)

sSI_I- Red soils in the area of the zonal shale. (Keyberg series)

sGC_I- Red soils in the area of the "Grand Conglomérat" (Mukuen series).

sGC - Yellowish red and yellow sandy soils in the area of the "Grand Conglomérat" (Association Misowa - Luano)

sSDr- Red dolomitic soils (Association Kasonta - Luano.)

sSDj- Yellow dolomitic soils (Association Munua - Kasombo).

e. Moderately well drained to imperfectly drained hydro-latosols.

eGS - Yellow clayey soils with motling in the area of the synclinal (Association Kasapa-Kampemba).

eGC_I- Yellow sandy soils with motling in the area of the "Grand Conglomérat"(Fipango series).

eSD - Yellow sandy-clayey soils with motling in the area of the dolomitic rocks. (Association Mwita-Mukambo).

d. Gray hydromorphic soils.

d₁ - Clayey gray hydromorphic soils (Association Mutwale-Muniama)

d₂ - Sandy gray hydromorphic soils (Kamelenga series)

a. Swamp soils on recent alluvium :

a₁ - Half bog on clayey sediment. (Lubumbashi series).

a₂ - Half bog on calcareous sediment. (Kisanga series).

Table

Quelques caractéristiques analytiques du latosol rouge sur calcaire de Kakontwe.
Some analytical data of the red latosol on the Kakontwe lime stone.

Horizon	Composition granulométrique										PH	Composition minéralogique				
	0	2	20	50	100	200	500	1000								
	2	20	50	100	200	500	1000	2000						Argile		
									% minéraux fraction sableuse	Inalté- rables	Potassiques	Calco- sodiques				
SH ₁	47,7	6,2	11,9	6,7	13,3	8,3	4,8	1,1	5,6	91	5	4	Illite principalemen peut-être un peu de kaolinite.			
SH ₂	53,2	6,9	11,7	8,0	9,4	6,2	3,7	0,9	5,9	89	4	7				
SNH	56,5	7,9	12,3	7,7	7,3	4,5	3,5	1,0	5,7	91	6	3				

SH₁ = Partie supérieure solum humifère ; Upper part of the humic solum.

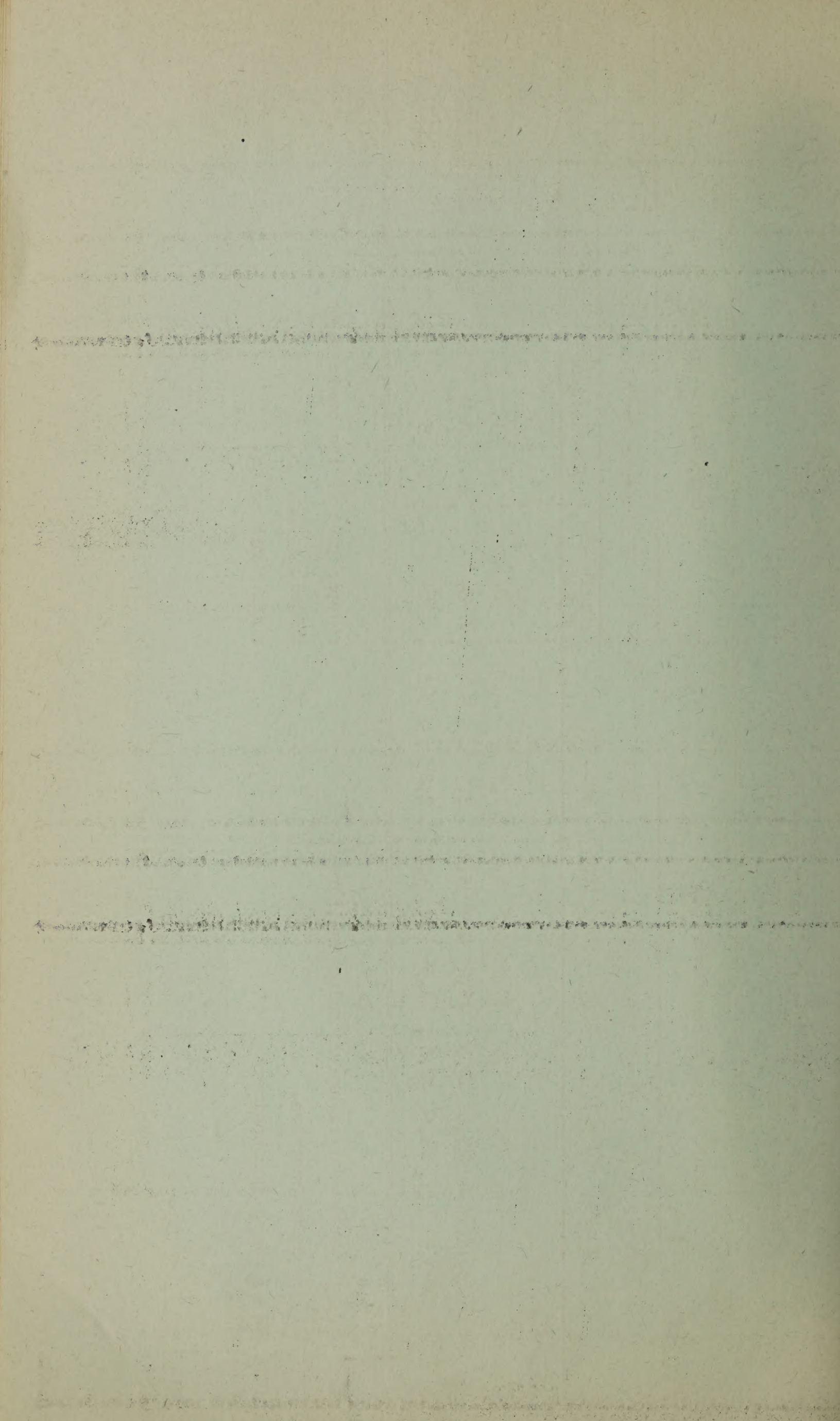
SH₂ = Solum humifère ; Humic solum.

SNH = Solum non humifère ; Non humic solum.

Quelques caractéristiques analytiques du latosol rouge sur dolomies.
Some analytical data of the red latosol on dolomitic rocks.

Composition granulométrique										PH	Composition minéralogique				A r g i l e
Horizon											% minéraux fraction sableuse				
	0	2	20	50	100	200	500	1000	2000			Inalté- rables	Potassiques		
SH ₁	29,6	6,4	15,6	11,9	19,5	9,5	6,2	1,3	6,0	84	3	13	Illite principalement, gibbsite entre 1 m. et 3 m.		
SH ₂	35,2	6,6	15,6	12,5	16,2	7,4	5,2	1,3	4,8	84	6	10			
SNH	43,4	7,3	16,6	12,6	11,5	4,2	3,2	1,2	5,3	84	5	11			

Illite
principalement,
gibbsite
entre 1 m.
et 3 m.



T A B L E A U IV
Table

- Quelques caractéristiques analytiques du latosol rouge-jaunâtre dans la zone remaniée du grand conglomérat, influencé par les grès de Mwashya.
- Some analytical data of the Yellowish - red latosol in the zone of the "Grand conglomérat"

Horizon.	Refus à 2 mm.	granulometrie								PH	Composition minéralogique					A r g i l e
		0	2	20	50	100	200	500	1000		% minéraux fraction sableuse					
												Inalté- rables	Potassiques	Calco- sodiques		
SH ₁	-	16,9	4,4	10,9	9,8	27,2	19,5	10,0	1,3	6,0	9I	4	5	Illite		
SH ₂	tr.	36,3	5,7	13,1	11,3	15,3	10,0	6,5	1,8	4,9	92	5	3	avec peut-être		
HG	83	34,0	6,2	12,5	9,5	12,8	6,8	8,2	10,0	-	94	I	5	un peu de kaolinite		

- SH₁ : Partie supérieure solum humifère - Upper part of the humic solum
- SH₂ : Solum légèrement humifère - Poorly humic solum
- HG : Horizon de gravier - gravel layer

Table

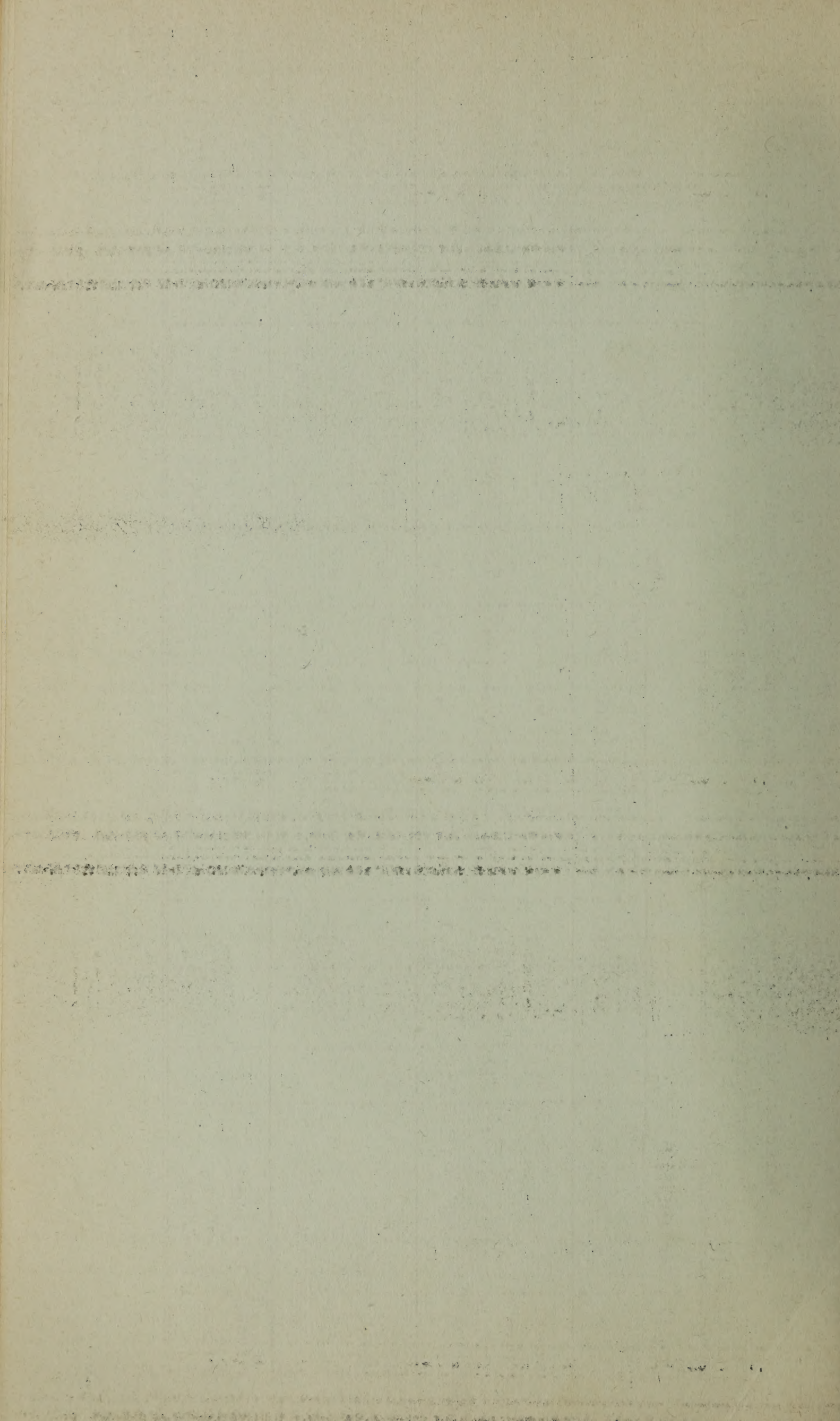
• Caractéristiques analytiques des sols dolomitiques (schistes dolomitiques)
Some analytical characteristics of the soils on dolomitic rocks.

PROFIL	HORIZON	granulométrie										PH	% Al_2O_3	% FeO	C %	N %
		0	2	20	50	100	250	500	1000	2000						
latosol rouge	SH ₁	50,0	6,7	10,8	5,3	9,8	8,8	7,5	1,1		5,2	24,10	8,14	5,68	0,500	
	SH ₂	62,2	4,8	10,6	4,8	8,3	5,2	3,3	0,8		5,2	27,48	8,62	0,93	0,086	
	SNH	64,1	5,3	11,8	5,2	6,2	3,6	2,8	1,0		6,0	27,99	8,86	-	-	
latosol jaune	SH ₁	37,3	4,4	11,3	5,3	13,7	16,7	10,7	0,6		5,2	21,19	3,59	3,12	0,193	
	SH ₂	51,5	3,1	11,7	5,2	11,2	9,4	6,9	1,0		5,2	25,80	3,83	0,67	0,065	
	SNH	57,1	3,7	13,4	6,4	8,5	6,2	4,7	0,8		6,0	24,78	3,83	-	-	
Hydro-latosol	SH ₁	24,7	3,9	14,1	8,3	21,3	17,5	10,0	0,2		5,9	24,46	2,63	0,75	0,058	
	SH ₂	56,0	3,7	14,1	5,9	8,7	6,5	4,6	0,5		5,7	-	1,20	0,24	0,022	
	SNH	54,3	4,9	15,6	6,7	8,2	5,7	4,1	0,5		5,6	23,60	1,44	-	-	
Profil gris-hydromorphe	SH ₁	41,8	10,3	12,1	4,1	8,0	10,6	12,4	1,1		5,1	-	-	3,60	0,313	
	SH ₂	44,4	5,7	11,1	4,0	12,0	13,3	9,3	0,2		5,2	21,19	2,63	0,78	0,064	
	SNH	54,4	7,1	14,3	4,7	7,5	6,3	5,2	0,5		5,4	19,89	2,63	-	-	

T A B L E A U
Table
VII

Caractéristiques analytiques de la catena dans la zone remaniée du grand conglomérat.
Some analytical data of the catena in the catena in the "Zone du grand Conglomérat".

Profil	Horizon	granulométrie							PH	Al ₂ O ₃ %	FeO %	C %	N %
		0	2	20	50	100	250	500	1000				
		2	20	50	100	250	500	1000	2000				
Latosol rouge- jaunâtre	SH ₁	24,8	4,1	13,0	6,9	21,5	19,3	9,8	0,6	14,20	5,77	1,79	0,143
	SH ₂	29,0	3,3	13,6	6,7	19,7	17,5	9,3	0,7	16,78	6,66	0,63	0,053
	SNH	38,9	4,5	15,7	8,1	16,5	11,0	5,1	0,2	18,39	7,55	0,20	0,022
Latosol jaune	SH ₁	17,6	4,7	13,9	7,3	23,3	18,4	13,5	1,3	10,15	4,00	1,38	0,114
	SH ₂	29,3	4,3	19,4	8,0	13,8	10,3	11,5	3,4	14,16	4,44	0,37	0,034
	SNH									16,72	4,44	0,19	0,023
Hydro-	0 - 10cm									-	-	-	-
Latosol	10 - 100cm									15,44	4,44	-	-
	100-150cm									13,85	5,77	-	-



INSTITUT NATIONAL
POUR L'ETUDE AGRONOMIQUE
DU CONGO BELGE.
=====

Elisabethville
Soil Survey.

SOIL STUDY OF THE ELISABETHVILLE AREA.
=====

by C. SYS.

Inéac Pedologist.

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I. GEOGRAPHIC SETTING

The area of Elisabethville and particularly the area to be surveyed is bordered as follows :

- North : II° 30' S.
- South : II° 50' S.
- West : 27° 17' East of Greenwich.
- East : 27° 40' East of Greenwich.

II. PHYSIOGRAPHY.

I. Geology :

The geology of the area belongs to the "Groupe du Katanga " which has been subdivided in two systems.

This subdivision is based on the presence of a continental incident with glacier characteristics. During this episode the "Grand Conglomérat" was formed.

The Upper System is the Kundelungu system, the lower system the Schisto-dolomitic system.

The Schisto-dolomitic system is subdivided in 2 series : an upper series and a lower series. The separation is marked by the apparition of the " Mwashya Conglomérat " which is sometimes characterised by green lumpy shales.

The stratigraphy of the schisto-dolomitic system is as follows :

Upper Series	10	Feldspatic sandstones
	9	Shales and limeshales.
Under Series	8	Conglomeratic layer(oolitic and hematitiferous layers)
	7	Lime stones and dolomites.
	6	Dolomites.
	5	Limestone with black minerals.
	4	Dolomitic shales.
	3	Zonal silicified dolomites with Stromatoliths
	2	Silicified dolomites in plates.
	1	Conglomeratic rock.

In the succession of layers forming the Kundulungu system, a conglomeratic formation exists reaching a thickness of 50 m. topped by pink or blue limestone.

This landmark has been chosen to subdivide the Kundulungu system in 2 series : An upper series and a lower series.

The stratigraphy of the Kundelungu system is as follows :

Upper Series	8	Macignos
	7	Reddish limestone
	6	Conglomeratic layer

Under	5	Macignos
	4	Shales and calcareous shales
Series	3	Kakontwe limestone
	2	Zonal shale
	I	"Grand Conglomérat"

All these series were subjected to the Kundelungu tectonic.

2. Topography and relief :

The general aspect of the relief is determined by the Kundelungu tectonic, the constitution of the rocks and the lithology. The ridges are always formed on the most hard rocks : sandstones of the Mwashya series and siliceous rocks of the Mine Séries.

Clay and carbonate rocks often appear in a lower topographic unit due to their faster weathering.

The general topography of the country is that of an old peneplain dissected by the actual riversystem; the aspect is gently rolling land or long flat slopes from which the altitude ranges from 1180 m. to 1250 m.

The formation of the peneplain is anterior to the Gamblian Pluvial.

The dissection of this peneplain took place during the Gamblian Pluvial;

The erosion surface on the flat of the hills which slope down to the valleys, date from the Upper Pleistocene, as indicated by its stone age implements.

The dry valleys were filled up with gray deposits and the warping is still active in the marshes of the river valleys.

3. Climate :

Table I illustrates the general occurrence and distribution of rain and temperature during the year 1952 at the Ineac experimental station of Keyberg.

Table I :

1952	RAINFALL	T E M P E R A T U R E		
		Average	Average	Average
		daily maximum	daily minimum	
January	200,6	27,9	17,19	22,54
February	453,5	26,96	17,18	22,07
March	110,6	28,11	15,39	21,75
April	59,5	27,82	13,75	20,78
May	1,3	27,07	6,79	16,93
June	---	25,57	5,13	15,35
July	---	26,0	3,35	14,67
August	---	28,7	5,2	16,95
September	---	31,77	9,28	20,52
October	21,8	32,4	11,7	22,05
November	187,8	27,9	15,7	21,8
December	184,4	28,5	16,1	22,3
Year	1.219,5	28,22	11,39	19,80

III. THE SOILS.

I. Genesis :

I. Classification of the superficial deposits in relation to the soils :

a. The Pré-Quaternary times :

The geologic basement of the area is composed by Pré-Cambrian and Cambrian rocks. They were plaited and faulted during the Kundelungu tectonic. After the tectonic, the Kundelungu ridges were levelled by erosion during the post paleozoic times, and in that way a sub-horizontal topographic surface was formed : the end tertiary peneplain.

Under the high level laterised gravels of this peneplain the rocks are deeply weathered; by the weathering process they furnished a reddish spotted shale, presenting the same aspect on all rocks. The formation of this weathering may be relatively old (tertiary or secondary ?)

The thickness of the reddish spotted shale generally diminishes when the slopes increase. On very ^{steep} slopes we only find coarse non or less weathered colluvial rockmaterial, while the non weathered rock is rather near to the surface.

The epirogenic deformations of the end tertiary peneplain determined the place of the hydrographic system at the beginning of the quaternary times.

b. The Pleistocene before the Gamblian Pluvial :

The pheromenons of lifting and epirogenic deformation which reversed the flow of some rivers during the middle of the Pleistocene times make the study difficult of the under and middle Pleistocene deposits.

At 80 Kms. north-East of Elisabethville we observe continental deposits represented by old terrace gravels, around the tertiary peneplain, they were laid down at a time when the river system was quite different from that of the present day. Mortelmans (5) found in these stone age gravels implements of the "Pebble culture" which permit him to attribute them to the Kagerian Pluvial.

On the borders of the lateritic platforms of the Elisabethville area, some isolated implements of the acheul culture (x) were found.

Mortelmans (6) attributes to the interpluvials of the under and middle Pleistocene the formation of lateritic crusts.

Notwithstanding that the history of under an middle Pleistocene of the Elisabethville area is very vague, these few observations permit a general conclusion that most lateritic platforms are composed of remains of lateritic crusts of which the formation is anterior to the Gamblian Pluvial.

The upper part of these plateaux are bordered by a bank of lateritic crust which contain some isolated Acheul implements. These permit us to attribute this formation to the Middle Pleistocene.

We call "Gravel I" all the lateritic gravels of which the formation is anterior to the Gamblian Pluvial.

c. The Upper Pleistocene :

The Gamblian Pluvial : According to Mortelmans (6) the tributary valleys in the Katanga were formed during the Gamblian Pluvial. The whole river system of the Elisabethville area is composed of tributary valleys of the Luapula.

(x) according to verbal communication of Dr. Fr. CABU, conservator of the museum Leopold II, at Elisabethville.

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It seems logical to us, to attribute their formation to the Gamblian Pluvial. During their formation erosion dissected the middle Pleistocene plain, with, as a result the formation of hill wash and terrace gravels on the erosion surface. We observe this gravel in some places in the form of a stone-line under the superficial deposits. We call them : Gravels II.

The interpluvial Gamblian - Makalian :

This episod is characterised by a semi-arid climate.

During this period was formed the most common gravel layer on hills and slopes. The presence of stone age implements of the "Culture Muhilienne" permit us to attribute this gravel layer to the Upper Pleistocene. It is our gravel III, according to the gravel layer described by Beugnies (I)

The initial materials of the superficial deposits which cover these gravels, must have been also formed during this semi-arid period. They agree with the eolien deposits, which Mortelmans (6) attributes to this interpluvial in the Katanga region.

d. The Epi-Pleistocene :

- The Makalian wet phase : During this wet phase the eolien deposits were subject to erosion. The rivers cut again through the eolien sands and removed them from the valleys. We suppose that at that time a formation of motling and gley was formed on the borders of the valleys. The zonal soils also began their pedogenetic differentiation.

- The dry post Makalian phase : Around quartz outcrops we found gravels including some stone age implements of the " Culture Nachikufienne" which permit us to attribute their formation to this period.

We also suppose that some valleys were filled up with eolien sands (redeposited Kalahari sands II of Leacky).

e. The recent Period :

- The Nakurian wet phase : The recent period is characterised by an erosion in the valleys where the redeposited eolien sands were partially removed.

Some dry valleys (dembos) occur on a sub-horizontal topography; in the middle of these valleys we observe a small channel which has a water output only during the rainy season.

During this recent wet phase the gley layer was undoubtedly formed in these very poorly drained deposits.

Other, sometimes very large dry valleys (dembos) are completely horizontal; they were filled up with a greyish clay or clayey sand "Swamp deposits". The central part of these valleys is sometimes still marshland.

It seems that the parent material of the intrazonal gray hydromorphic dembo soils was formed during this period.

It also seems to us that the dembos (dry valleys) are old river valleys filled up :

- by eolien deposits which evoluated to gray hydromorphic soils.
- by "Swamp deposits" represented also by gray hydromorphic soils.

-- Actual deposits :

The warping of marsh land is still continued actively at the present day.

In table II we give a synthetic classification of the superficial deposits of the Elisabethville area in relation to the geo-genesis of the soils.

2. Géo-genesis of the soils :

a. Geo-genesis of zonal soils and their classification. according to the geo-morphology :

The zonal soils of the Elisabethville area are developed in the weathering products of the rocks of the "Groupe du Katanga". According to Beugnies (I) the profile developed in the zone of superficial weathering is composed of different layers and we observed the same succession in all the zonal soil profiles.

- The layer of superficial deposits.
- The gravel layer.
- The layer called "allites siallitiques"
- The reddish spotted shale.
- The weathered rock.
- The intact rock.
- The layer of superficial deposits :

The colour of the superficial deposits varies a lot and ranges from dark red to yellowish red for the upper catena soils.

In the synclinal (on calcareous shales and macigno~~s~~) they are yellowish-red (5 YR 5/6), on the Kakontwe limestone they are red to dark red (10 R 4/6 to 3/4). In the area of the "Grand Conglomérat" where they are influenced by silicious rocks they are yellowish-red (5 YR 5/6); on dolomites and dolomitic shales they are red to dark red.

The texture also varies according to the nature of the underlaying rock. The medium texture of some profiles of each geomorphological unit is represented in table III.

According to Beugnies (I) they contain in the surroundings of calcareous rocks (Kakontwe limestone, calcareous shales) calcium carbonate concretions. We observed the presence of these concretions on all the rocks, but they are abundant in the surroundings of calcareous rocks. Their presence always go together with white ant activities, and the same concretions are observed in the heart of anthills. They represent a recent biological formation.

In some profiles on the Kakontwe limestone mineral calcium carbonate concretions were observed. But here the layer of superficial deposits was removed by erosion and in reality the concretions were present in the layer of the reddish spotted shale.

The thickness of the superficial deposits ranges from 0,10 m. to 4 m. The maximum thickness is observed in the red soils on dolomites and on Kakontwe limestone.

Sometimes the layer of superficial deposits has been removed by erosion and the gravel layer appears at the surface.

The most coarse parts of the mineral fraction contain, besides the quartz minerals, an important quantity of dark red concretions.

The clays are principally composed of illite mixed with some kaolinite.

TABLE II.

Attempted scheme of classification of the superficial deposits of the Elisabethville area in relation with the soils.

LAYER	CLIMATE	STRATIGRAPHY	CULTURE	SOILS
ACTUAL	ACTUAL	Actual Swamp deposits	-----	a- Marsh soils - " Half Bog "
		-- Filling up of the dry valleys by Swamp deposits		d- Grey hydromorphic soils in the horizontal dry valleys
RECENT	COMPLEX	-- Formation of gley in the dry valleys	-----	d ₀ -Grey hydromorphic soils in the sub-horizontal dry valleys
	NAKURIAN	-- Formation of motling on gley on the borders of the valleys		e- Hydro-latosols with motling.
	WET	-- Removal of eolian deposits in the valleys	-----	
	PHASE	-- Removal of eolian deposits in the valleys		
		-- Erosion		
		-- Erosion		s- Farther development of zonal soils.
	POST MAKALIAN	-- Redeposited eolian sands		HV- Upper valley soils
	LIAN DRY	-- Gravels IV		g ₂ - non laterised gravels
EPI	PHASE	-- Sub aerian erosion	NACHIKUFIEN	g ₁ - Laterised gravels ?
PLEISTOCENE	MAKALIAN	-- Formation gley and motling on the borders of the valleys ?		e- Hydro latosols
	WET	-- Removal of eolian deposits in the valleys		s- Beginning of the development of the latosols in the post Gamblien deposits.
	PHASE	-- Removal of eolian deposits in the valleys	-----	
		-- Erosion		
	INTERPLUVIAL	Eolian deposits		s- Initial parent material of zonal soils
	GAMBLIEN	-- Laterisation of gravels III ?		g ₁ -Laterised gravels
UPPER	MAKALIAN	-- Gravels III	MUHILLEN	g ₂ -Non laterised gravels.
PLEISTOCENE		-- Hill wash gravels-gravels II		
	GAMBLIEN	-- Formation of the tributary valleys		
	PLUVIAL	-- Erosion		
	INTERPLUVIAL	Laterised gravels		ACHEUL ?
MIDDLE	KANGERIAN PLUVIAL	-- Periods of laterisation and erosion	Gravels I	g ₁ - Laterised gravels.
PLEISTOCENE	INTERPLUVIAL	--		
NE				
UNDER	KAMASIAN PLUVIAL	-- Beginning of the dissection of the tertiary peneplain by a riversystem		
PLEISTOCENE	INTERPLUVIAL	--		
	KAGERIAN PLUVIAL	--		
TERTIARY	-----	End tertiary peneplain		

TABLE III.

Main texture and colour of a typical soil profile of every geomorphological unit.

Geomorphological unit	Colour	% of the fraction.									
		0	2	20	50	100	200	500	1000	2000	
G S area	5 YR 4/8 to 2,5 YR 5/8	54,6	6,6	23,1	7,5	3,5	1,2	1,7	1,8		
C K area	10 R 4/6	56,5	7,2	12,3	7,7	7,3	4,5	3,5	1,0		
S I area	-										
G C area	5 YR 4/6	39,6	8,5	13,0	9,0	14,3	8,3	5,1	2,2		
S M area	-										
Dolomites											
S D area	10 R 4/6-3/6	36,5	10,6	22,9	12,5	8,0	2,8	2,5	4,2		
Dolomitic shales		64,2	5,6	11,8	7,0	5,0	2,9	2,5	1,0		

We consider the initial superficial deposits as an eolian deposit of the Upper Pleistocene.

Yet the near relationship between the constitution of these deposits and the underlying rocks or the geo-morphological units wants some explanation. If it is really a eolian deposit we suggest two hypothesis for its origin :

- a. The initial superficial deposits are the product of mechanical weathering of the surrounding rocks which were locally transported and were accumulated there.
- b. Or the deposit was accompanied by phenomena of water streaming which mixed particles originating from wider areas with particles of the substratum.

These superficial deposits were subject to erosion during the wet and dry phases of the Epi Pleistocene, properly speaking they constitute altered eolian deposits on the plateaus and hill wash deposits on the slopes (eluviums and colluviums).

- The gravel layer :

The discordancy between the superficial deposits and the reddish spotted shale, product of weathering of the under-lying rock, is characterised by a gravel layer.

Sometimes this gravel layer is only composed of a stone-line, of which some elements are well rounded and others are angular.

This stone-line appears on the slopes towards some river valleys and they determine the erosion surface of the Gamblian Pluvial.

Yet the most common gravel layer has a thickness which ranges from 30 cm. to 1 m. We observe this gravel on nearly all the topographic units.

These gravels were described by Beugnies (I). They are composed of different materials : shales, psammite, sandstone, quartz. Generally the elements are not rounded. The quartz fragments present sharp edges and borders, the shale fragments are platy.

The size of these elements reach and are sometimes more than 0,30 m. Some of the smaller elements (a few mm) bear marks of mechanical handling : rolled or blunt angles.

A light limonitic skin often covers the gravels.

These gravels originated from the surrounding rock; they were not subject to an important transport. They constitute the real eluviums of the Upper Pleistocene, dated by the presence of stone age implements of the Muhilian culture, and according to a sub-desertic climate.

- The layer called "allites siallitiques"

Beugnies (I) called the lateritic crust developed in the Upper Pleistocene gravels "horizon des allites siallitiques".

This lateritic crust, can be observed on the lower slopes near the valleys.

In the zonal soil profiles of the plateaus and the upper slopes we never observe this lateritic crust, but only lateritic concretionary material originating from an older laterite and admixed to the Upper Pleistocene gravels.

As indicated by Beugnies (I) we ascertained that this laterite is developed in the gravelly layer, the gravels are cemented by iron oxydes.

According to the classification system of D'Hoore (3) it is an absolute accumulation of iron oxydes in a reception material which is the Upper Pleistocene gravel layer.

- The reddish spotted shale :

The layer of the reddish spotted shale of which the thickness ranges from 5 to 15 m. represents the weathering product in the place of the underlaying rock.

We also observe this layer under the gravels I.

Therefore its formation dates of a relatively older geological episode (tertiary or secondary).

- The weathered rock :

The thickness of this horizon ranges from 0,30 m. to 1,5 m. It only differs from the underlaying rock by a greater friability and some local variations as decolorization, hydratation and oxydation.

- The parent rock :

According to Beugnies (I) all the rocks manifest phenomenons of microscopical weathering.

We observed that the lithological characteristics of the superficial deposits, and the soils are in relationship with the geomorphological unity. Therefore the first criterion in classifying our soils is based on the geomorphological units.

It was during the pre-quadernary period that the general outlines of the morphology of the country were formed according to the Kundelungu tectonic, the composition of the rocks and the lithology.

The general morphology of an anticlinal and a synclinal is represented in figure I of excursion I.

The dolomitic rocks, in the heart of the anticlinal occur in an area of lower altitude, due to their fast weathering.

The shales and sandstones of the Mwashya series together with the "Grand Conglomérat" are very resistant to erosion and often determine well continuous ridges.

The area of the Kakontwe limestone is always characterised by a well marked depression.

The transition between the hills with shales and sandstones of the Mwashya series and the depression on the Kakontwe limestone occurs on a moderately steep slope.

We remark sometimes between the "Grand Conglomérat" and the Kakontwe limestone a rockoutcrop characterised by the zonal shale. This is the case at Keyberg.

At last the clayey and carbonated rocks of the synclinal determine a very large area of lower topography.

Following unities are therefore noticed :

I. The area of the synclinal -GS-

In this area all soils have a clayey texture.

The most red upper catena soils are yellowish red (5 YR 5/6) to light red. (2,5 YR 5/8) The main texture of a typical profile is represented in table III. The variations in texture are represented in the diagram of excursion I.

2. The flattened area of Kakontwe limestone -CK-

In this area one finds red to dark red clayey, deep well drained latosols.

The main texture of a typical profile is represented in table III and the variations in texture in the diagram of excursion I.

3. The area of the zonal shale -SI-

This geomorphological unit appears under a steep slope and is most often characterised by lithosols on rock outcrops, bordered by a band of red soil resting on gravel.

4. The "Grand Conglomérat" area -GC

In this area we observe sometimes red soils on the basic conglomerat. Nevertheless; most soils of this area are influenced by the Mwashya sandstone; their texture is clayey sand and their colour is yellowish red (5 YR 5/6).

The main texture for a typical profile is represented in table III and the variations in texture in the diagram of excursion I.

5. The ridge determined by the Mwashya shales -SM-

This unity is mainly characterised by lithosols.

6. The dolomitic area : -SD-

The upper catena soils of the dolomitic area are red to dark red (10 R 5/6 to 3/4).

The texture varies according to the relative influence of dolomites or dolomitic shales. On dolomites we have red sandy-clayey soils; on dolomitic shales, red clayey soils.

The main texture for a typical profile is represented in table III. The variations in texture for the soils on dolomites is represented in the diagram of excursion I.

b. Geo-genesis of intra-zonal soils :

-Imperfectly and moderately well drained soils :

The geological profile is also composed of a layer of superficial deposits, a gravel layer and a layer of reddish spotted shale which gradually passes to the underlaying rock.

The superficial deposits are generally hill wash materials.

- Poorly drained soils in the dry valleys :

These gray hydromorphic soils are developed in recent colluvial materials.

In the sub-horizontal dry valleys the gray colluvium lies on a variable depth on the gravel layer representing the eluviums of the Upper Pleistocene, which passes in depth to the layer of the reddish spotted shale.

The horizontal dry valleys are filled up by swamp deposits.

- Very poorly drained soils :

The parent material of this swamp soils results from the actual warping of the marshy river valleys. The very recent composition of these deposits is explained by the presence of peat-bogs found under poorly drained sediments.

c. Geo-genesis of azonal soils :

- Lithosols :

This soils occurs on rock outcrops.

The loose gravelly material which covers the weathered rock has to be considered as eluvium.

- Lithogenic paleosoils :

In this group we have classed the soils, of which the formation is anterior to actual times : Laterite and fossil gravels.

3. The pedo-genesis of the soils :

a. Pedogenesis of zonal soils :

The development of zonal soils is determined by a very intense vertical washing.

The eluvial horizon is very deep and includes : the layer of superficial deposits, the gravel layer and the layer of reddish spotted shale.

In this eluvial horizon the weathering of minerals is about complete. On the other hand the chemically poor soil indicates a washing of all the weathering products.

The eluvial horizon passes immediately to the weathered parent rock without intervention of an illuvial horizon (B). Thus when we consider migration of soil constituents the profile is a typical A - C profile characteristic of senil soils.

In a same lithological unity (geomorphological unity) we observe, in relation to topography and according to differences in pedo-climate, red soils and yellow soils, both well drained.

Nevertheless in the red soils we only observe the mottling at a depth of about 10 m. whereas in the yellow soils mottling may be present at 1,5 m. to 2 m. The different position of the mottling indicates a wetter pedo-climate for the yellow soil and therefore a more intense washing.

We suppose that the yellow soil is developed in the same red material as the red soil, in which, under the influence of a wetter pedo-climate, the iron oxydes are partially washed out.

This hypothesis seems to be confirmed by the analytical data represented in table IV.

We therefore distinguish two phases in the development of zonal soils; the red soils having only passed the first phase and the yellow soils having passed the two phases.

I. The first phase is characterised by an enriching of iron and aluminium oxydes.

When the watertable is sufficiently deep, the chemical weathering is always related to an oxydation, which transforms the present iron in trivalent iron. The substratum being neutral we also notice a more intense migration of silice than of sexquioxides.

Therefore the sexquioxides enrich the upper part of the soil and give it a typical red colour.

2. The second phase is characterised by a washing of iron oxydes, due to a more humid pedo-climate :

It is a well known fact that iron oxydes in tropical soils are principally fixed on the colloidal mineral particles (clay) of the soil. Thus by aggregation stable aggregates are formed (pseudo-clays, pseudo-silt, pseudo-sand).

The precipitation of ferric oxydes on the surface of the mineral soil particles is, under well determined conditions, a reversible phenomenon.

Under a more humid pedo-climate the vegetation acts by increasing the quantity of organic matter. In a humic environment, the trivalent iron is transformed in bivalent iron, and becomes very moveable. Aluminium escapes from that reduction process and in that way differs from iron.

We then suppose that the washing of ironoxydes caused a degradation of the stable aggregates, which permits us to propose the hypothesis : Red latosol degradation → Yellow latosol.

TABLE IV.

Contents in Al_2O_3 and FeO , of some soil profiles on the most important lithological unities, according to the chemical analysis, effected by the chemical laboratoire of the Union Minière du Haut Katanga.

Lithological unity	Soil	% Al_2O_3	% FeO
Calcareous shale of the upper Kundelungu system	Red soil	20,91	8,00
	Yellow soil	18,19	6,22
" Grand Conglomérat "	Red soil	16,78	6,6
	Yellow soil	16,72	4,4
Dolomitic Rocks	Red soil	26,52	8,54
	Yellow soil	23,92	3,75

b. Pedo-genesis of intra zonal soils :

- Hydrolatosols :

These are imperfectely and moderately well drained soils the watertable has a rise of 2 to 3 m. in the wet season.

Superficial horizons are washed out and mottling appears at about 50 cm. to 100 cm. depth.

It is interesting to say that the highest position of the watertable is actually situated at about two to three meters under the upper part of the mottled layer. This statement permits us to suppose that the watertable has gone down from 2 to 3 m. since the wet Nakurian phase, and therefore this mottling may be a fossil formation.

Very often, these profiles show that in the upper part of the mottled layer, there is a slight increase of small elements. (Analysis table IV of excursion III hydrolatosol on dolomitic rocks.)

- Gray hydromorphic soils :

These are poorly drained soils which appear in catena with the well drained red and yellow and the imperfectly drained soils.

In spite of their relative position these soils are alternately water logged during rainy seasons and very dry during dry seasons.

= Tex. 13

After a heavy rain, however, flood waters will recede rather rapidly from the surface of these soils.

The soil profile is completely gray, reduction and washing is maximum.

Organic matter has been completely destructed by fires.

-- Half bog :

The half bog soils of marshland include very poorly drained soils developed on recent swamp deposits and alluvium.

They occupy permanently wet lowlands.

The profile is composed of a layer of organic matter (muck) which lies on a humic clay that becomes completely gleyified with depth.

c. Genesis of azonal soils :

These profiles are characterised by arid areas.

Azonal soils of the Elisabethville area thus include lithosols with little natural soil. Two groups can be distinguished :

- Lithogenic soils : Soils developed on paleozoic rock outcrops only show a very little profile differentiation.

Drainage is also excessive because of the steep topography.

The profile is composed of a thin organic layer which passes immediately in the weathered rock.

- Lithogenic paleosoils :

These are old zonal or intra-zonal soils, in which pedo-genetic processes have now completely stopped.

It is the gravely and lateritic substratums which present no actual profile differentiation. The appearance of the paleosol at the surface is due to the scouring of the superficial deposits by erosion.

2. Soil classification.

In this brief study we only classified the soil series.

The soil series, include the different profiles which underwent the same migration phenomenons from a same parent material.

It is thus that all profiles developed in a same geo-morphpological unity in a special pedo-climate belong to the same soil series. 11

Topographic variations observed in each geo-morphological unity are sufficient to cause a whole range of different pedo-climates, occasioning the development of as many pedological unities.

At places where the water table is sufficiently low, chemical alteration goes together with oxydation, and the most red soils are observed for a well determined lithological unity. On the other hand, a reduction area is found in marshy valleys and the soil is completely grey. The transition between these two extremes is done gradually passing through a series of different pedo-climates each corresponding to a degradation of red soil.

As morphological properties go together with pedo-genetic phenomenons, we have been able to make out a classification of our soil series, according to the above-mentioned principles.

The main difference in our soil series is therefore the consequence of the migration of certain constitutive soil elements from one parent material

In tables V to X, we give a synthetic classification of the soil series of the Elisabethville area.

All these series can be subdivided in lower unities according to the depth of the gravel layer, local variations in colour and texture of the upper solum.

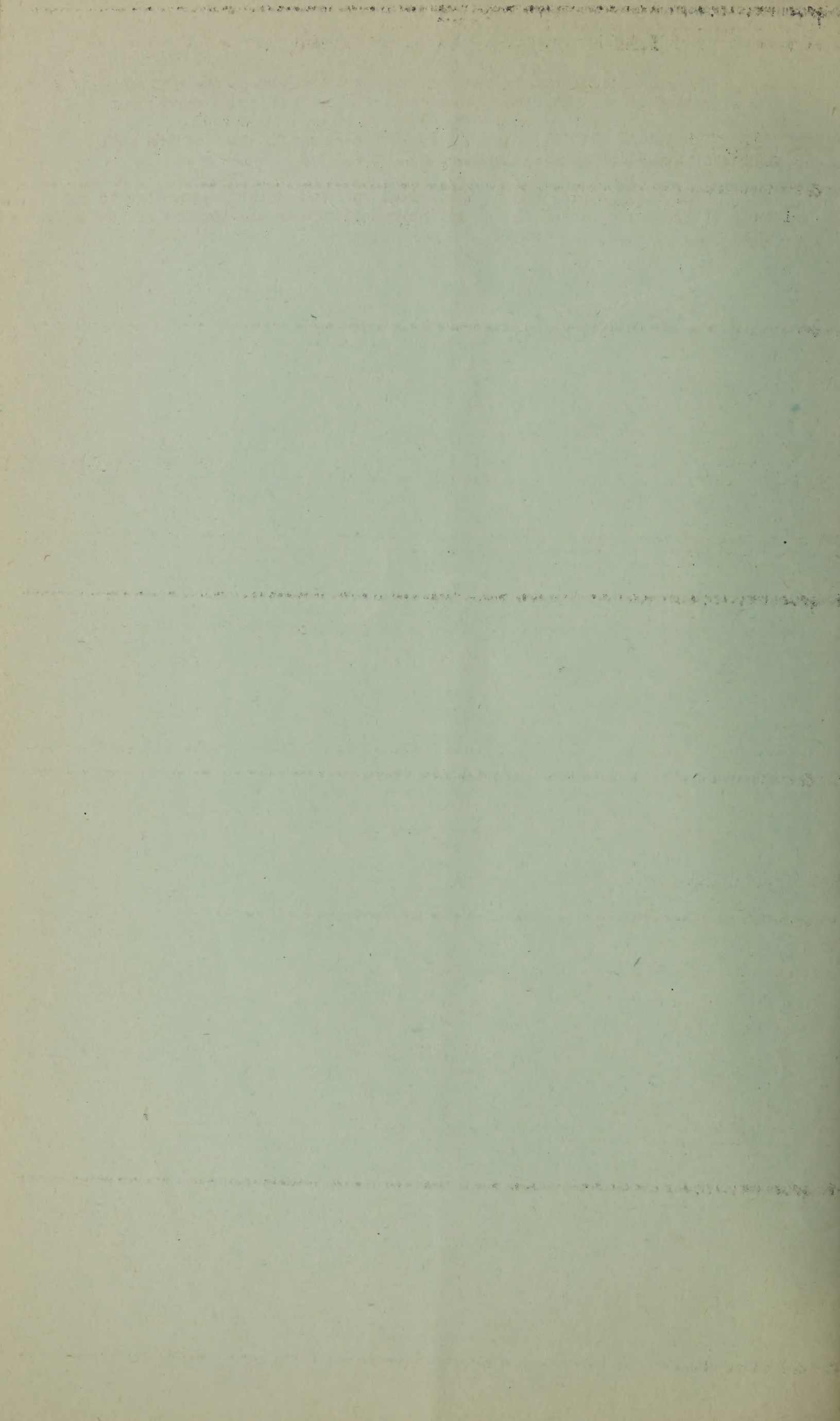


TABLE V
=====

The soil series in the synclinal area - GS -

eGS₂ - KASAPA Series

MUNIAMA Serie very poorly drained

eGS_I - KAMPEMBA Series

d_I MUTWALE Série Dessication + fire a_I - LUBUMBASHI S.

Imperfectly or
moderately well
drained

Poorly drained

Very poorly
drained

Washed eolien deposits

Colluviums Swamp deposits
Alluviums

PARENT
MATERIAL

NO DIFFERENTIATION

RGS - Lithosols
g_I - KATUBA Serie
g₂ - KISANGWE Serie

Eolien deposits and
colluviums
on - Calcareous shales
macignos

Well drained

sGS_I - KAPONDA Serie (yellowish red)

Degradation

sGS₂ - MUSAONGA Serie (yellow)

TABLE VI .
=====

The soil series in the flattened limestone area
of Kakontwe - CK -

a₂ - KISANGA Serie

Very poorly
drained

Calcareous
Sediment

PARENT
MATERIAL

NO DIFFERENTIATED

g_I - KATUBA Serie

Washed eolian
deposits on
limestone

Well drained

sCK_I - KIPUSHI Serie (red)

TABLE VII.
=====

The soil series in the area of the
zonal shale - SI -

Parent material
originating from
the zonal shale

----- NO DIFFERENTIATED
RSI - Lithosol.

Well drained

sSI_I - KEYBERG Serie (red)

TABLE VIII.

=====

The soil series in the " Grand Conglomerat " area - GC -

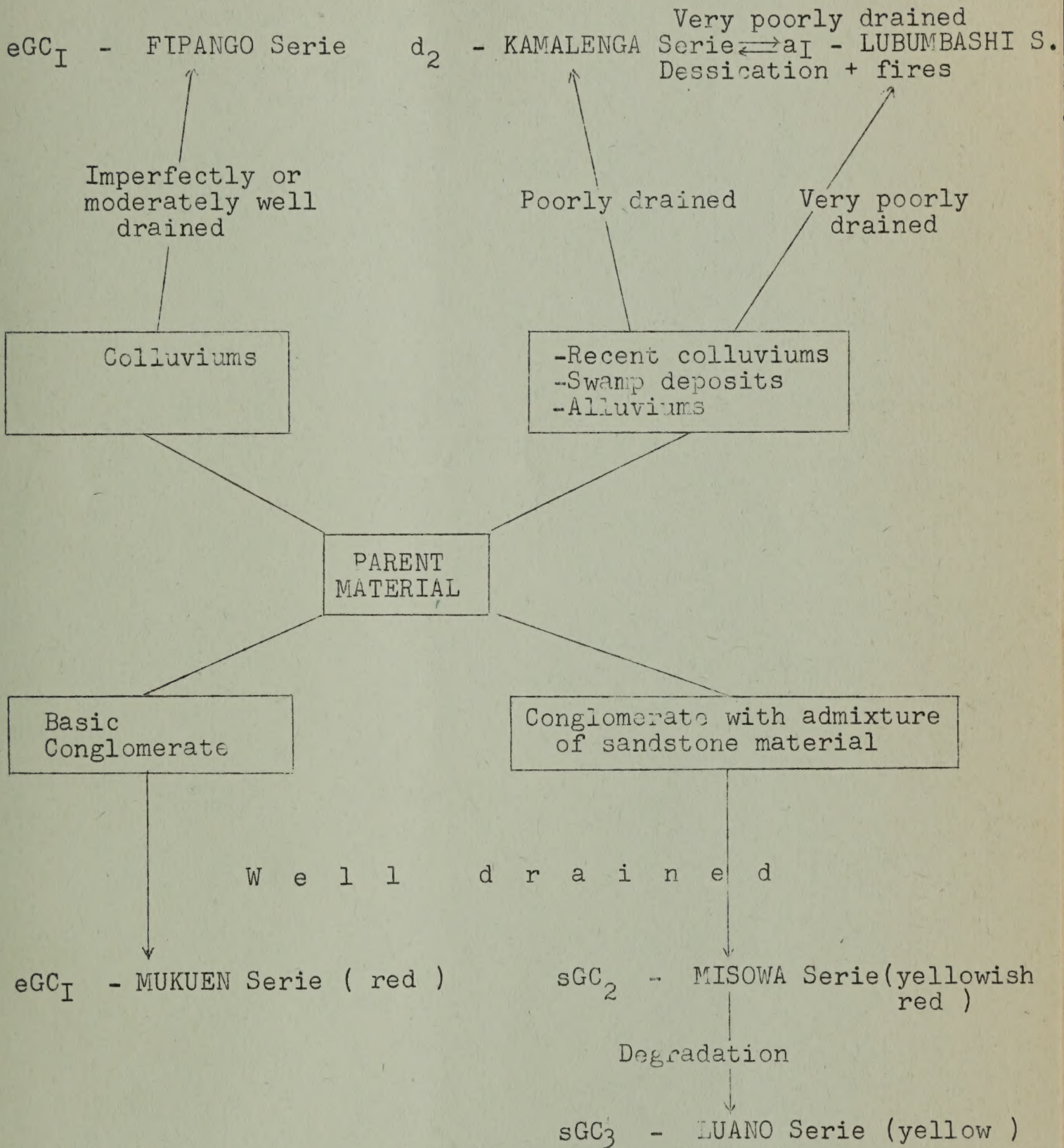
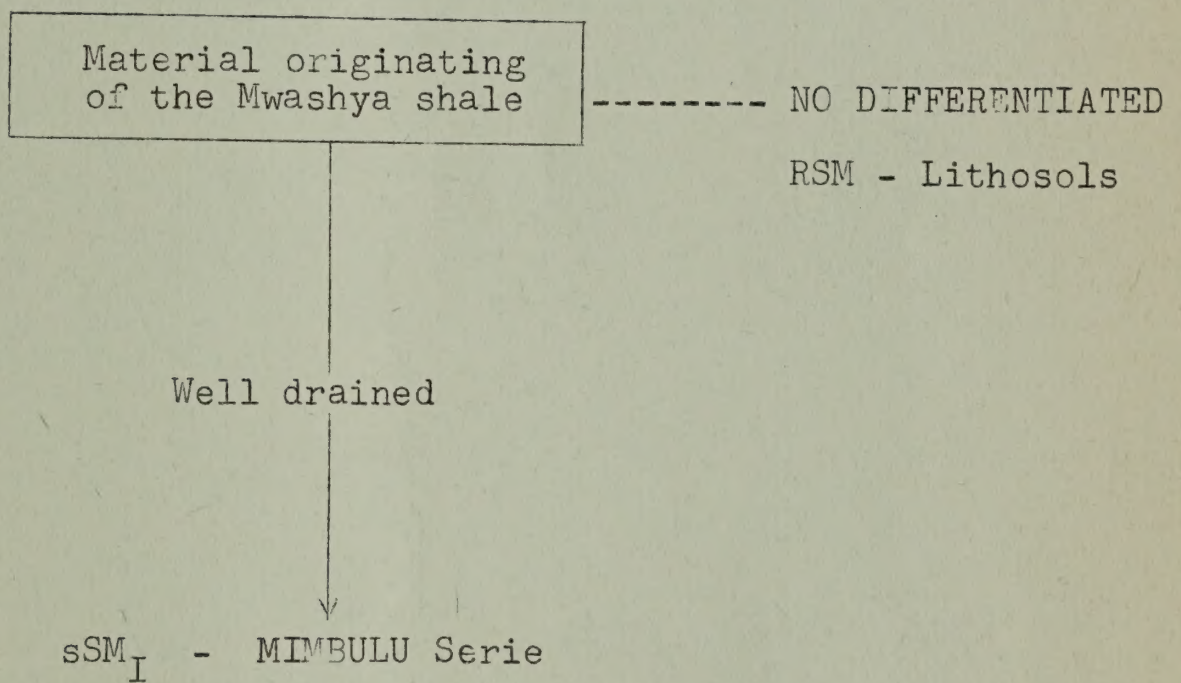


TABLE IX.
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The soil series in the sandstone
and shaly ridge of the Mwashya series -SM -



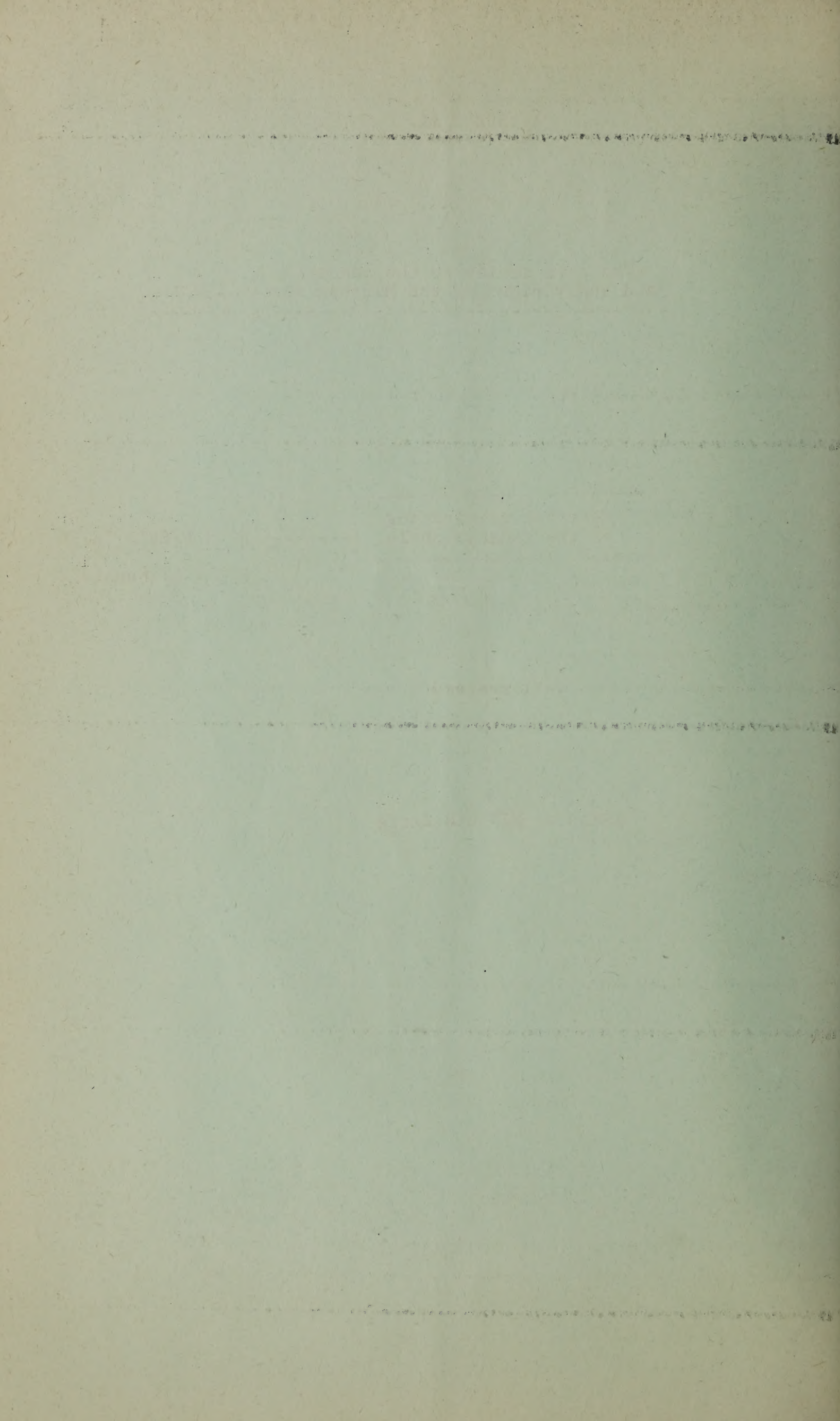
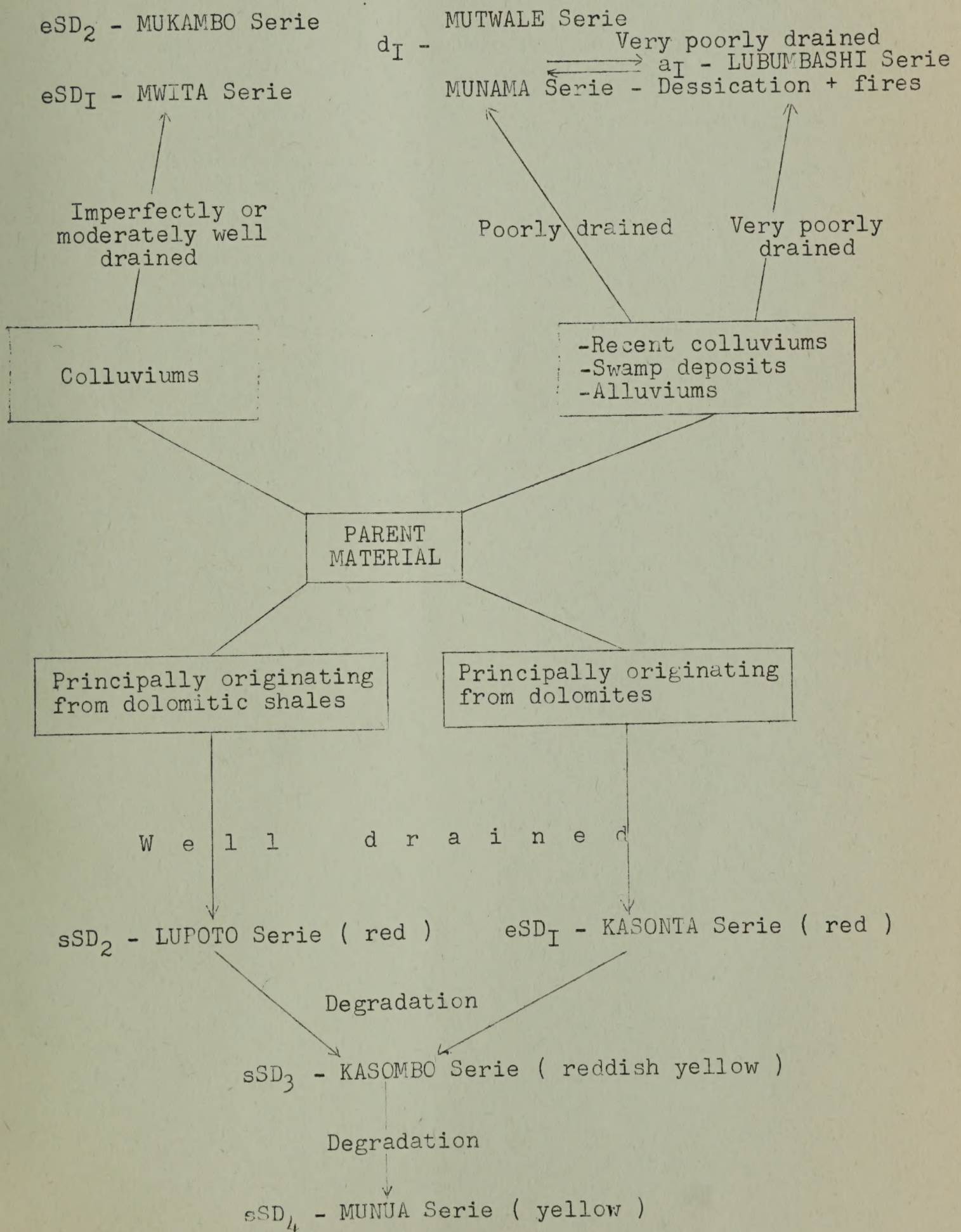


TABLE X.

=====

The soil series in the dolomitic area - SD -



3. Classification of great soil groups

The zonal soil profiles described in this study are developed under tropical climate; they show all the characteristics of completely weathered and washed soils.

In fact, we notice that all the horizons situated on the weathered rock constitute according to this rock one eluvial horizon A. This eluvial horizon passes immediately to the parent rock without interposition of an illuvial horizon.

According to Kellog (4) we call all these soils "latosols" which is a suborder.

In the Elisabethville area we find red and yellow latosols.

The separation of these two groups is based on differences in vertical migration of soil constituents, and particularly of ferric oxydes.

According to the petrographic nature of parent material we distinguish in the great soil group of red latosols eminent variations in the colour of the soil. Those formed on limestone and dolomitic rocks are red, those formed on clayey and siliceous rocks are yellowish red.

The transition between zonal and intrazonal soils is characterised by a pale yellow, mottled soil, of which the pedo-genetic processes were clearly influenced by a periodic high watertable. We call this profile a hydrosol, when situated in the area of latosols we used the term hydrolatosol.

The poorly and very poorly drained soils are respectively gray hydromorphic and halfbog soils.

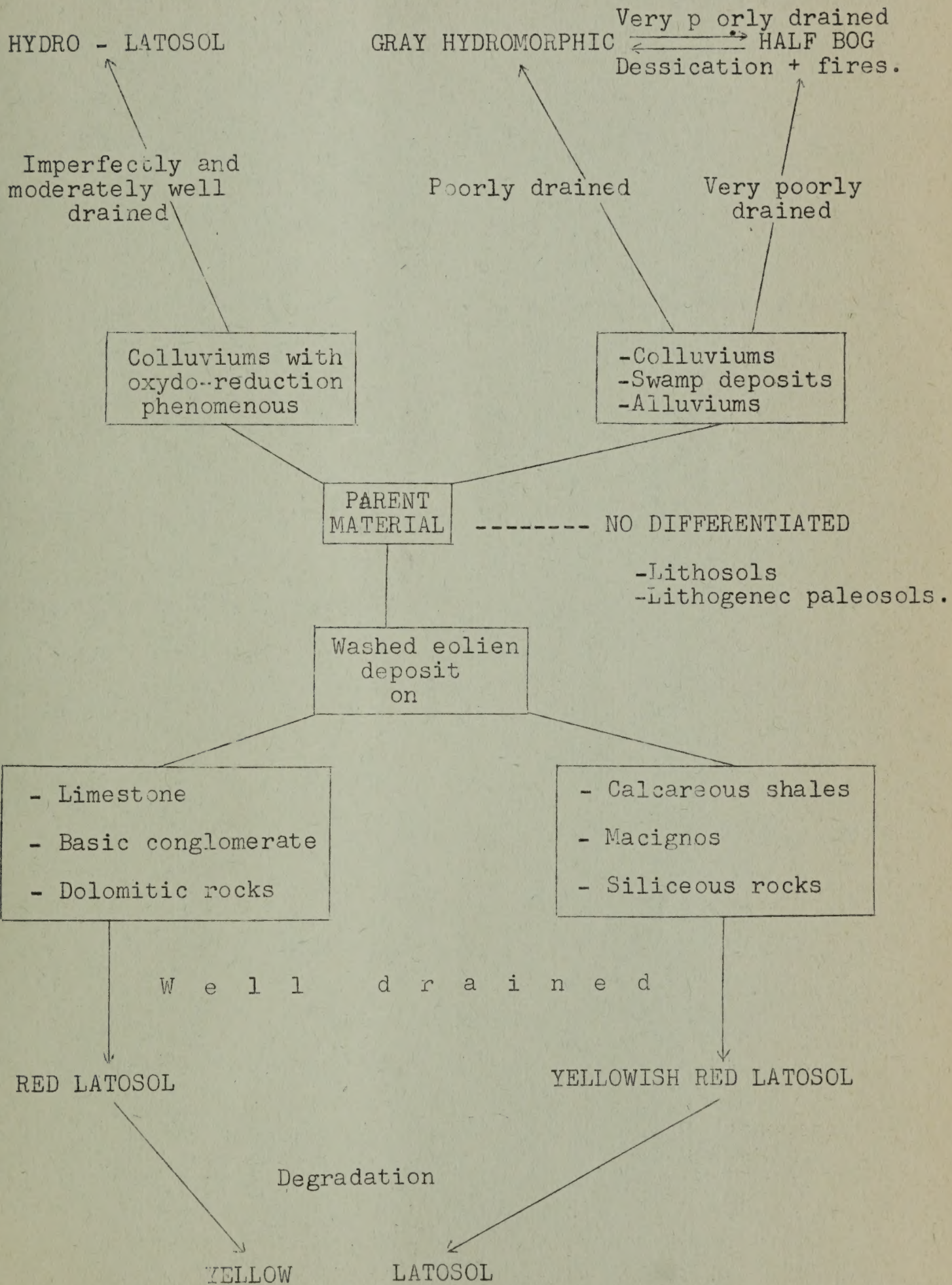
At last the azonal soils include profiles with little or no differentiation, we distinguish : lithosols and lithogenic paleosols.

In table XI we give a general diagram of the classification of the great soil groups of the Elisabethville area which represents the general conclusion of this study.

TABLE XI.

=====

The great soil groups of the Elisabethville area.



LITTERATURE.

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- (1) Beugnies - La nappe phréatique des environs d'Elisabethville et les phénomènes connexes d'altération superficielle
- Rapport C.S.K.
- (2) Beugnies - La tectonique Kundelunguienne - Academie Royale de Belgique.
Classe de Sciences mémoires - Col 8° Tome XVII-Fascicule 8.
- (3) D'Hoore T - Mission C.E.E.C.- pour l'étude des phénomènes de latérisation - Rapport INEAC 1951.
- (4) Kellogg & Davol - An exploratory study of the soil groups in the Belgian Congo - Publ.INEAC serie scient. n° 46.
- (5) Mortelmans - La préhistoire du Congo Belge et de l'Afrique Sud-Saharienne.-
- (6) Mortelmans - Vue d'ensemble sur le quaternaire du bassin du Congo - Congrès International des Sciences Préhistoriques et Proto-historiques Zurich 1950

I gather that most of the ground-water Latérite that I described had had some erosion during a dry period and later superficial depositions, much altered by leaching.

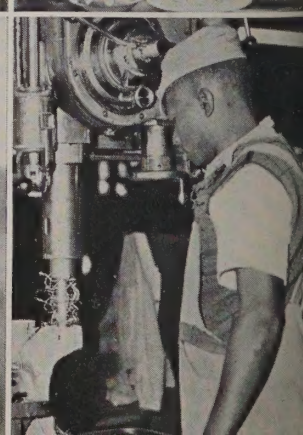
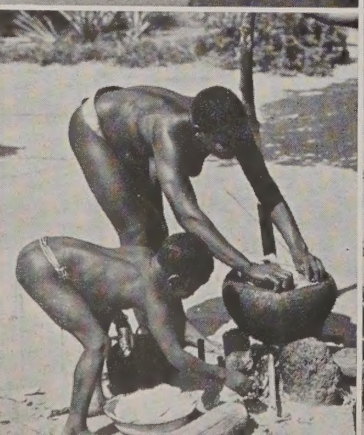
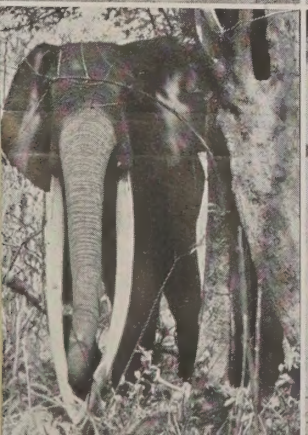
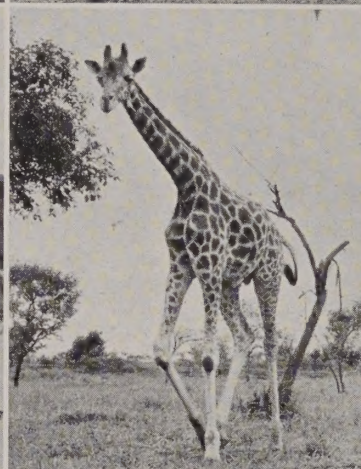
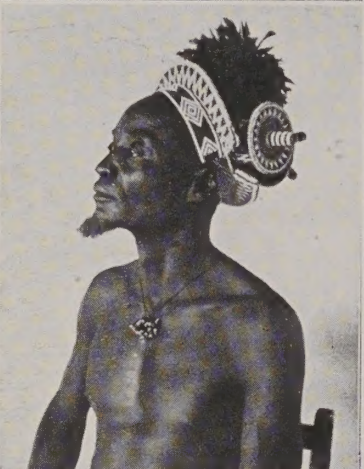
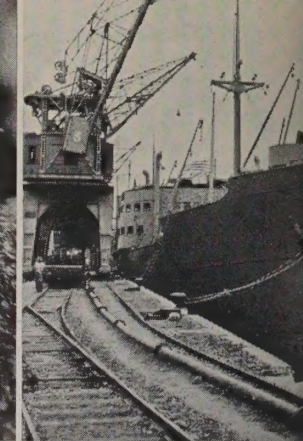
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HIER

27



AUJOURD'HUI





HIER ET AUJOURD'HUI

Le Congo Belge occupe la situation la plus centrale de l'Afrique; c'est pourquoi, sans doute, il fut longtemps considéré comme une terre inaccessible et meurtrière.

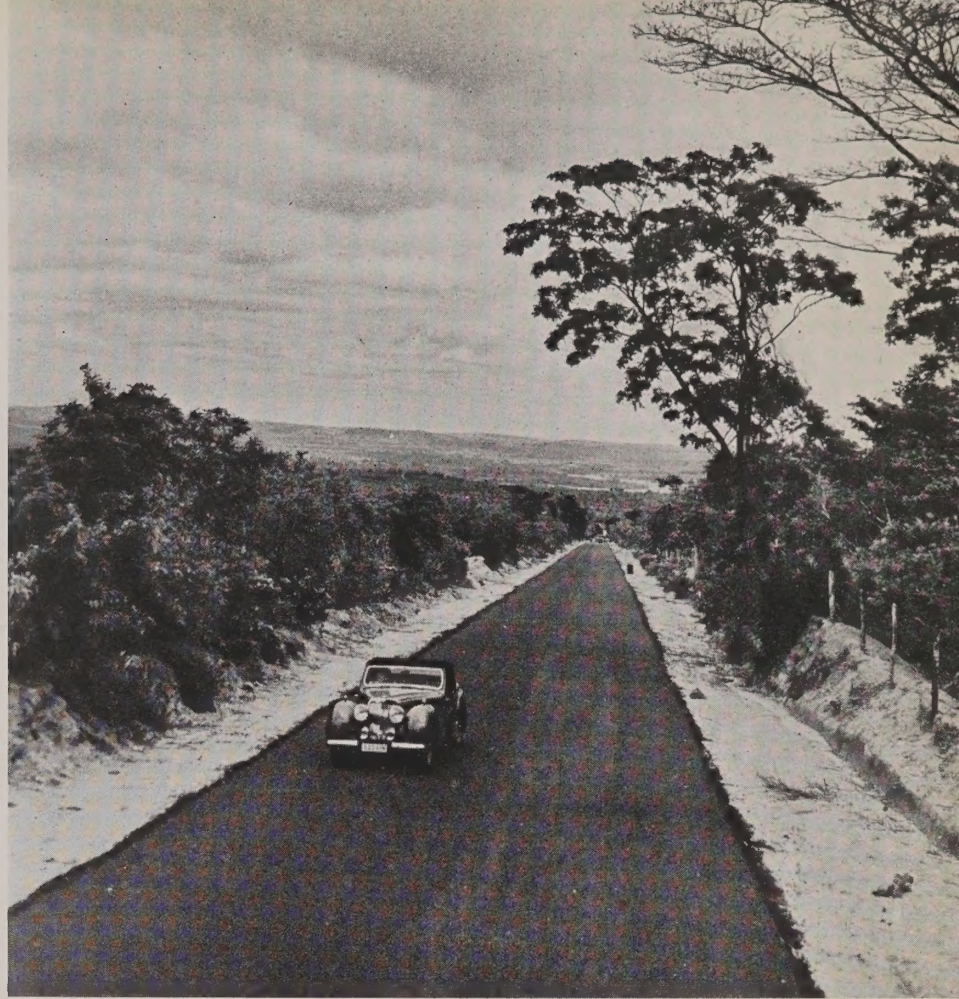
Lorsque, au prix de difficultés inouïes dues à la nature du terrain, aux cataractes, à l'ardeur du climat et à la sauvagerie des indigènes, Stanley parvint à la traverser, le monde entier qualifia cet exploit de surhumain. Là où, il y a soixante-quinze ans, l'illustre explorateur ne rencontra qu'une gamme disparate de tribus farouches et rivales, en proie à l'épouvante et à la haine car impitoyablement décimées par les luttes fratricides, les razzias des chasseurs d'esclaves, la maladie et la faim, vit pacifiquement aujourd'hui une communauté de près de douze millions d'hommes noirs.

En dépit des obstacles de tous genres opposés par une nature taillée à une échelle qui écrase l'homme, il n'est pas un village perdu dans l'immensité de la forêt équatoriale qui n'ait des contacts réguliers avec les messagers du progrès : médecins, missionnaires, agronomes, administrateurs.

L'évolution de l'agriculture, sous l'empire des méthodes rationnelles, modifie peu à peu le mode de vie des populations rurales. Dans des cités modernes, surgies comme par miracle au cœur de la brousse, des centaines de milliers de Congolais connaissent maintenant un genre de vie qui eût défié l'imagination de leurs grands-parents. De cette masse, se dégage lentement une élite : artisans et employés qualifiés, assistants médicaux et agronomes, éducateurs, prêtres et religieuses noirs. Elite restreinte sans doute, mais d'une valeur telle que, d'ores et déjà, se pose le problème de son assimilation au statut juridique et social des peuples d'Europe.

Le nouveau visage du Congo est loin cependant d'avoir entièrement effacé l'ancien. C'est l'étonnant contraste entre le passé encore partiellement vivace et le présent, ébauche d'une destinée pleine de promesses, qu'évoquent ces quelques images.

















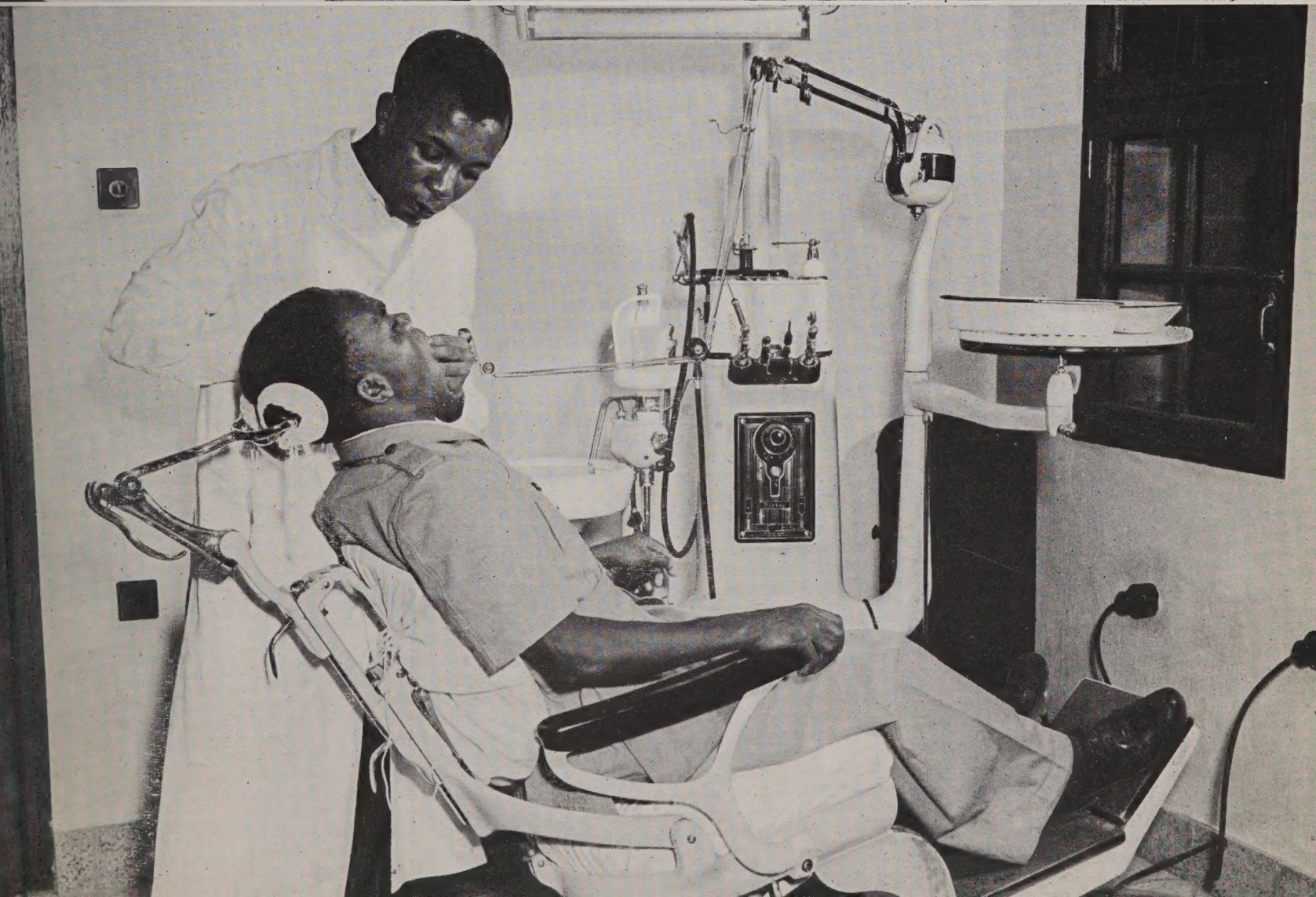






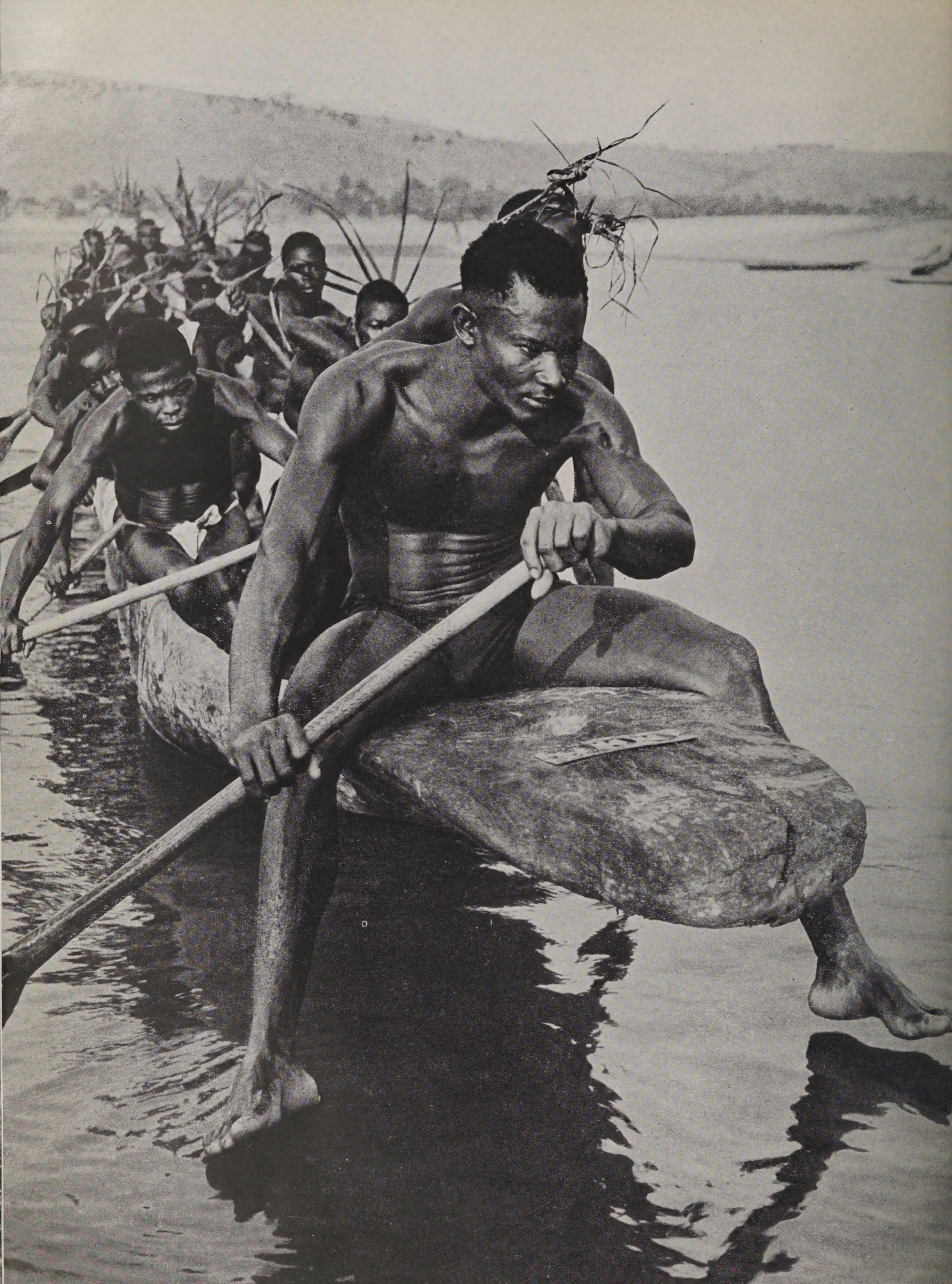




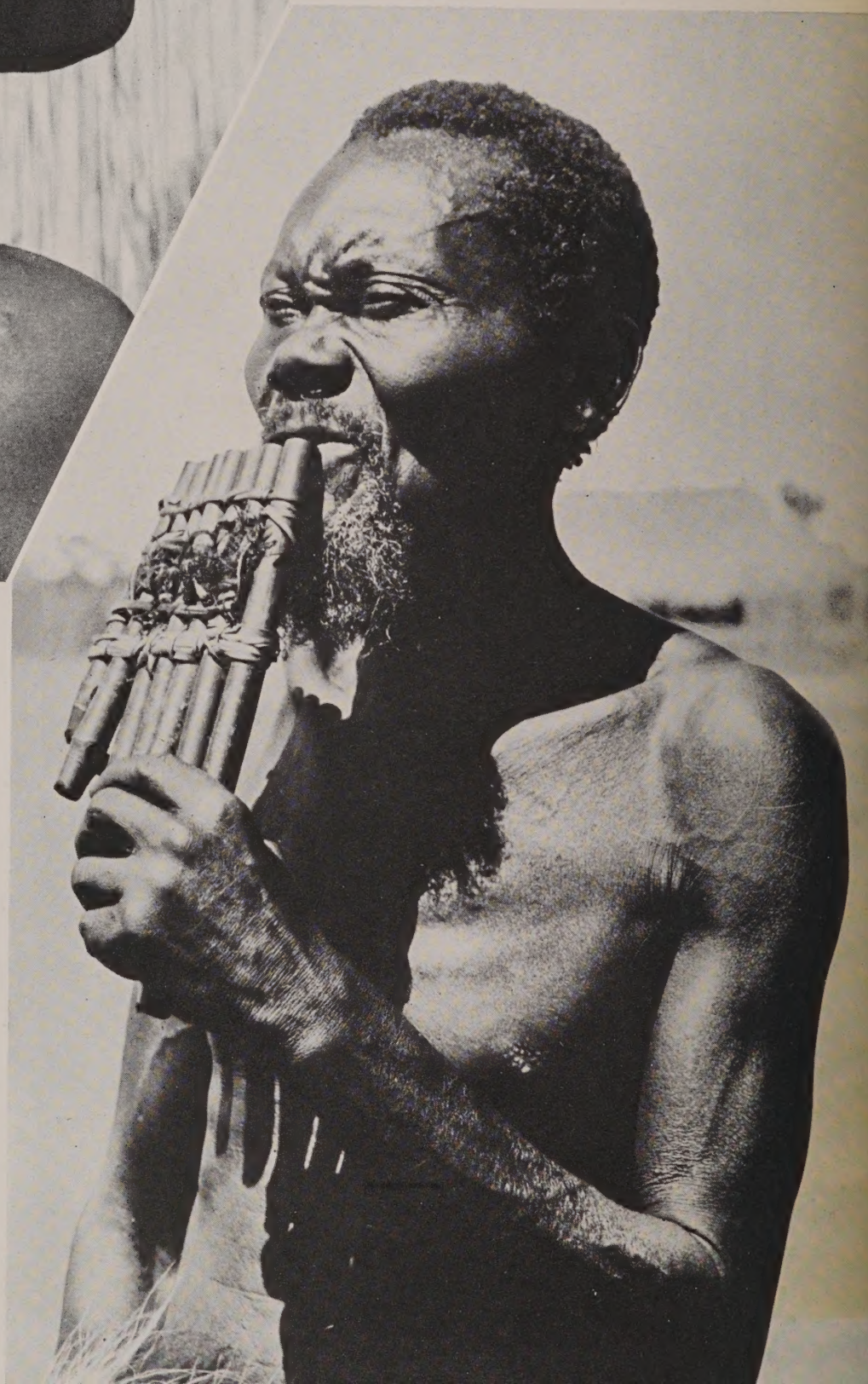






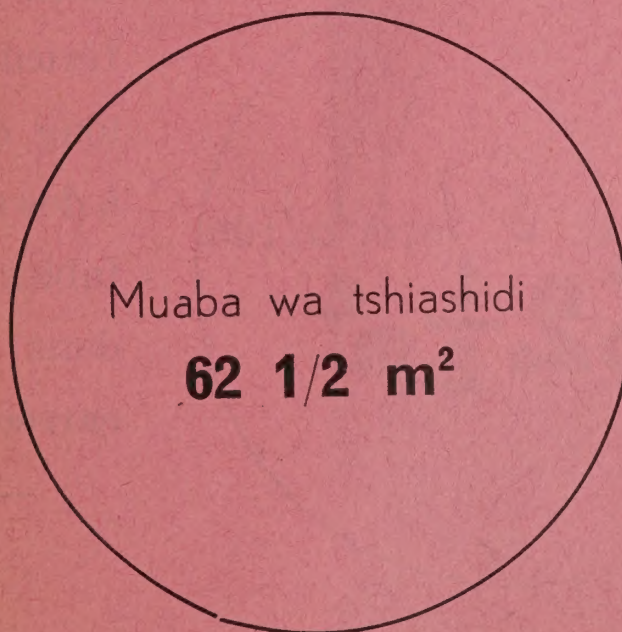
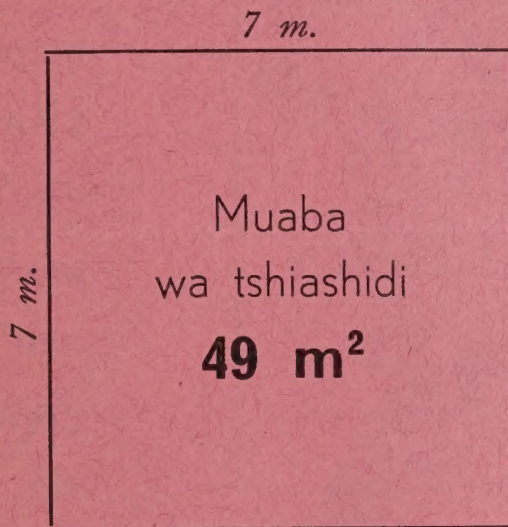
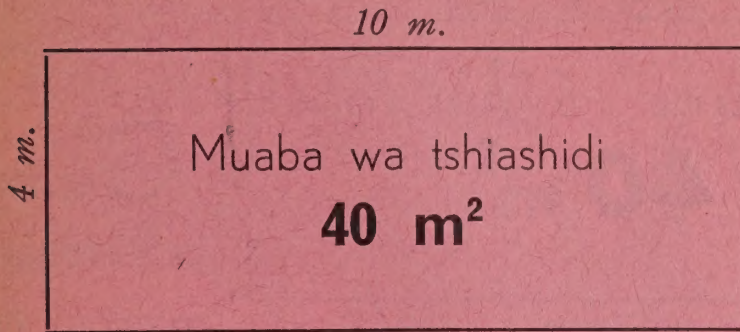






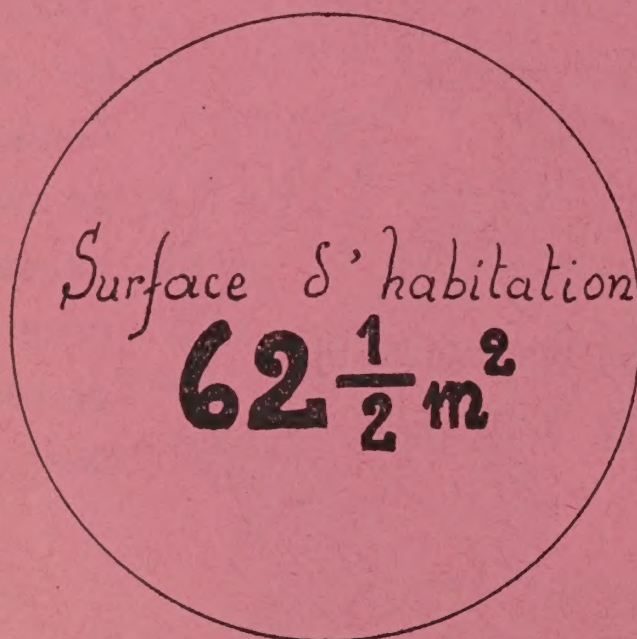
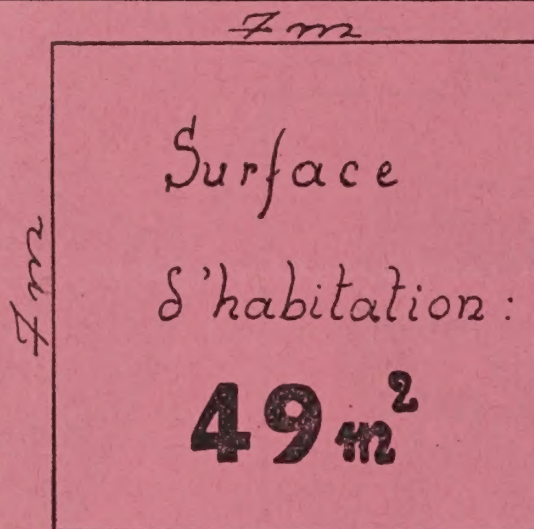
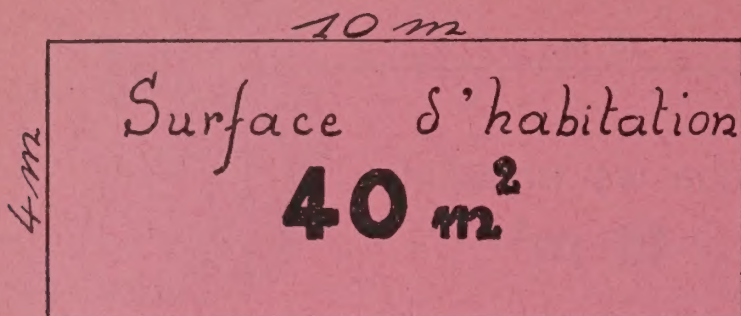
ASA NZUBUEBE

Bulu bua mumwe ne tshimana tshia pa mbelu
Muaba wa tshiashidi mupite bunene !



M bitambe bui-
mpe nzubu ikale
wa nseke yonso
bule mumwe (*car-
rée*) ani wa tshije-
ngu (*ronde*): mu-
shinga udi mua
kutula bia bimané
udi mushadile ku
nzubu wa mukoka-
koka. Dessin wetu
udi uleja mudi bi-
mane bia pa mbelu
bia 28 m. mubule
bikale bia mumwe
ne miaba idibo mua
kuasa mipite bu-
nene mu nzubu ya
carrées ne ya **ron-
des**.

CONSTRUIS ta MAISON



Construisez de préférence votre maison **carrée** ou même **ronde** : les frais d'élévation des murs sont moindres que dans une maison rectangulaire. Notre dessin montre comment des murs extérieurs de 28 m. de long correspondent à des surfaces habitables plus grandes dans les maisons **carrées** et **rondes**.

Même longueur du mur extérieur
Surface habitable plus grande !





Whalley Taylor

(28)

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Change-over 2nd December, 1953.

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11th November, 1953.

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